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FUEL — ELECTRICITY — MACHINERY — METHODS

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JULY, 1924

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DETROIT.

Mechanical and Electrical Analyses of 40-inch Blooming Mill Screw Down

By F. D. EGAN

Electrical Engineer, Bethlehem Steel Company
Lackawanna, N. Y.

The Giant Power Survey of Pennsylvania

By JUDSON C. DICKERMAN

Assistant Director, Giant Power Survey, State of Pennsylvania
Harrisburg, Pa.

Calumet and Crawford Avenue Stations of the Commonwealth Edison Company, Chicago, Ill.

By W. F. SIMS

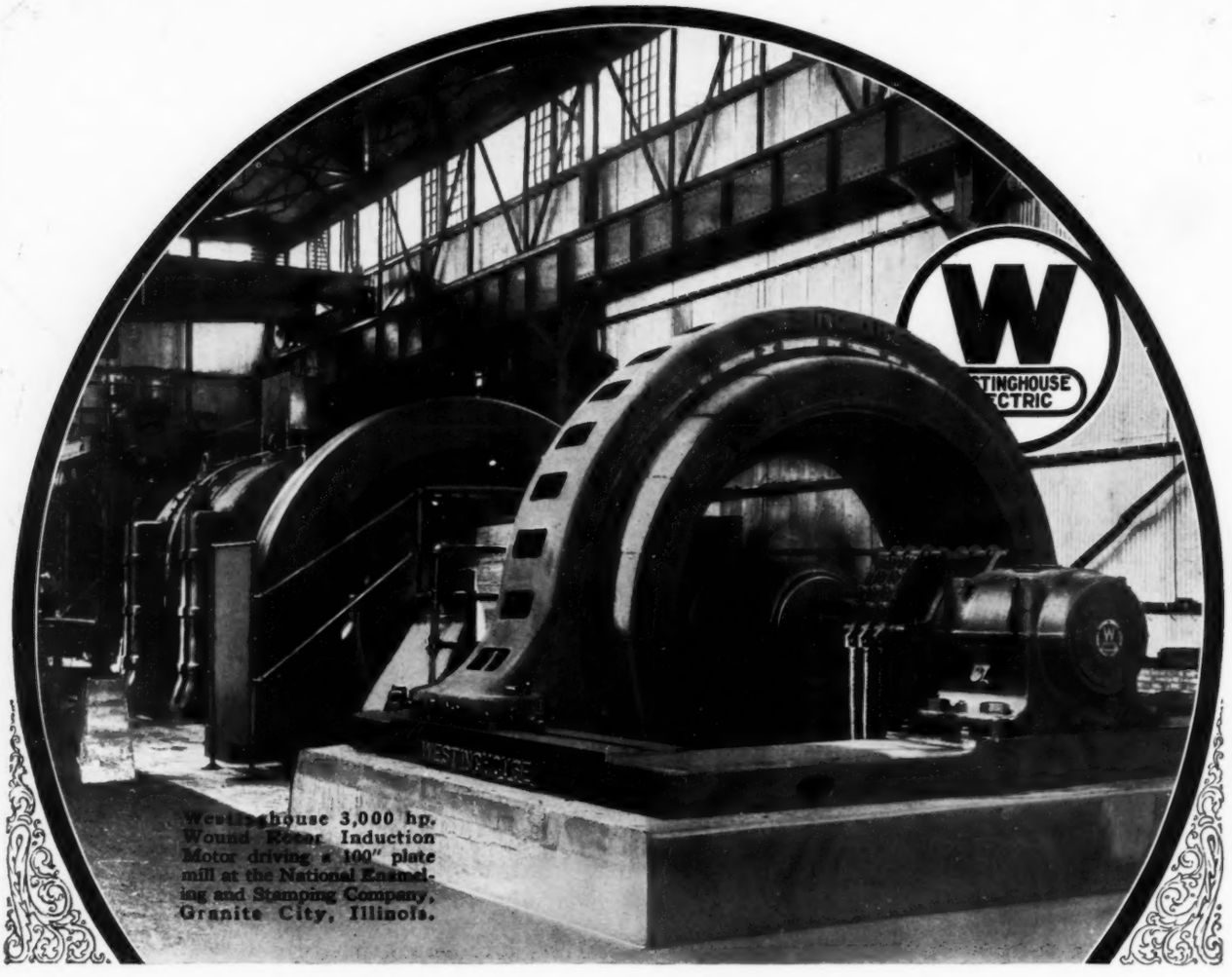
Engineer, Commonwealth Edison Company
Chicago, Ill.

Decisions of the Public Service Commission of the State of Pennsylvania Relative to Rates of Electric Light and Power Companies

By F. HERBERT SNOW

Chief, Bureau of Engineering, Public Service Commission
State of Pennsylvania, Harrisburg, Pa.

R v.12 July-Dec. 1929



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J. F. KELLY, Editor

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Published Monthly by

Association of Iron and Steel Electrical Engineers

706 Empire Building, Pittsburgh, Pa.

Entered as second-class mail matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879.

Subscription Price $5.00 per Year. Single Copy 50c.

BENJAMIN G. LAMME

BENJAMIN G. LAMME, honorary member of A. I. & S. E. E., chief engineer of the Westinghouse Electric & Manufacturing Company, and one of the world's leading electrical authorities, after a lingering illness of several months, died July 8, 1924, at his home, 230 Stratford Street, East Liberty, Pa., where he lived with his sisters, Miss Florence A. Lamme and Miss Lenna G. Lamme.

George Westinghouse, with whom Mr. Lamme was closely associated until Mr. Westinghouse's death, had perfected the alternating current system, by which electricity could be transmitted over great distances economically. Mr. Lamme then perfected railway and industrial motors and synchronous converters to make this alternating current useful at any point, and thus the use of electricity was removed from small, restricted areas and its use made universal.

His most spectacular achievements were the designing of generating equipment for the World's Fair in Chicago in 1892; 5,000-hp. generators, a world's record at the time, when Niagara Falls was first harnessed for waterpower; generating and motor equipment for the first big railway electrification, that of the New York, New Haven & Hartford Railroad; the present day single-phase alternating current, high voltage railway system, which is responsible for most of the railroad electrifications; the design of the most successful synchronous converter ever used; and the single reduction gear street car motor, which though designed in 1890 is the type still used on street railway systems.

An outstanding trait in Mr. Lamme's character was his interest in young engineering students. For years he made a study of the young, technical graduates who entered the Westinghouse Electric organization, analyzing their abilities and characteristics to adapt them to the work to which they were best fitted. He maintained a design school for these men, in which he gave actual instructions, so that today the methods and knowledge of this great genius have been passed on to the vast Westinghouse engineering body and will stand as an inheritance to these engineers in years to come.

B. G. Lamme was born on a farm near Springfield, O., January 12, 1864. He entered Ohio State University in 1883 and graduated in mechanical engineering in 1888, having been out of school during the year 1886-1887, on account of his father's illness and death. He had but little opportunity to study electricity, as there was no electrical engineering course at that time. He had, however, taken a great interest in the subject and picked up all the information he possibly could. He entered the employ of the Westinghouse Electric Company in 1889, at the princely salary of $30 a month.

The design of motors and generators in those days was mainly a matter of "cut and try," of experiment pure and simple. Albert Schmid, at that time superintendent of the Westinghouse Electric, felt that electrical phenomena must be subject to natural laws just the same as materials are. So having heard of young Lamme, whose greatest delight was to "figure," he gave him the task of trying to discover these laws and devise methods for calculation of electrical machines

(Concluded on Page 408)

BENJAMIN G. LAMME

EDITORIALS

ELECTRIC LIGHT AND POWER RATES

IN this issue we have some salient decisions of the Public Service Commission of the State of Pennsylvania, affecting electric light and power rates, and analysis of the cases cited. The decisions rendered make it imperative, when about to purchase light and power, that both your electrical and legal departments co-operate to the fullest extent; otherwise, your contracts will always be subject to misunderstandings.

A light and power contract is no purchasing agent's job, and perhaps this accounts for the reason why so many light and power contracts are being continually referred to Public Service Commissions for adjustment. However, there are enough decisions cited to enable an electrical and legal department in any steel plant to draw up a contract which will at least avoid the misunderstandings and mistakes made in the past.

ELECTRICAL DEVELOPMENT COMMITTEE REPORT

MR. E. S. Jefferies, chairman of the Electrical Development Committee, solicits your co-operation in the preparation of the Electrical Development Committee's report, to be presented at the fall convention.

Any development, no matter how minor in your opinion, should be reported to this committee, as only in this way do we serve our true purposes—the enlightenment of the engineer for service. Address your communications to Electrical Development Committee, A. I. & S. E. E., 706 Empire Bldg., Pittsburgh, Pa.

NINETEENTH ANNUAL CONVENTION

COMMITTEES are busy in the preparation of plans for the nineteenth annual convention, to be held in Pittsburgh September 15th-20th, 1924. Reports from the various committees would indicate that the convention will be the largest and best attended in the history of the Association.

Headquarters will be at the William Penn Hotel, and reservations should be made at once. Address Mr. A. C. Cummins, Chairman, General Arrangements Committee, 706 Empire Bldg., Pittsburgh, Pa.

The Million Dollar Show, this year to be held at Duquesne Garden, will surpass anything the Association has attempted so far. Practically all the space has been sold to the leading manufacturers of the United States, and arrangements have been made to take care of 50,000 visitors that week. The hours for the exposition will be 1 until 10 P. M. The technical sessions will all take place in the Ball Room of Duquesne Garden. The hours for the technical sessions will be 9:30 A. M. to 1 P. M.

Many of the steel plants in the Pittsburgh District will throw open their doors to the visitors for their inspection. The central stations in this district are also arranging to show the visitors some of the most modern methods of producing power.

The committees in charge of the convention are as follows:

General Arrangements—A. C. Cummins, Electrical Engineer, Carnegie Steel Company, Duquesne, Pa.

Technical Sessions—R. S. Shoemaker, President A. I. & S. E. E., American Rolling Mills Company, Middletown, Ohio.

Papers—S. S. Wales, Electrical Engineer, Carnegie Steel Company, Pittsburgh, Pa.

Iron and Steel Exposition—John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa.

Banquet—A. J. Standing, Electrical Superintendent, Bethlehem Steel Company, Bethlehem, Pa.

Information—F. W. Cramer, Assistant to Electrical Superintendent, Bethlehem Steel Company, Johnstown, Pa.

Registration — George Schaeffer, Electrical Superintendent, Carpenter Steel Company, Reading, Pa.

Inspection — James Farrington, Superintendent Electrical Department, Wheeling Steel Corporation, Steubenville, Ohio.

ANALYSIS OF 40-INCH BLOOMING MILL SCREW DOWN MOTOR

MR. F. D. Egan, Electrical Engineer, Bethlehem Steel Company, Lackawanna, N. Y., presents a paper in this issue which is of great interest to those plant managers who are endeavoring to equip their blooming mills with a view of speeding up production and effecting economies through one of the main arteries, the screw down motor.

The author in this paper has demonstrated through extensive research and analysis that it is possible to secure the ideal the steel mills are seeking—a method of motor application to a screw down, which will guarantee the continuity of operation, using about half the power which was formerly used.

How the author arrived at his conclusions is pictorially illustrated through oscillograph tests, charts, curves, and tables.

This is one of the most complete papers, with reference to motor applications to screw downs, that has been presented before the Society for a number of years. You are invited to contribute to the discussion which will appear in the August issue of the Iron and Steel Engineer.

MAINTENANCE

TODAY is the time for the maintenance departments of the steel industry to make the necessary repairs to their machinery, in order to be able to meet, in the very near future, the consumers' demands. The practice of the past, "No Business—No Maintenance," has gone forever, and the majority of the steel companies today are taking advantage of the low market prices of both raw and finished products to place their plants in such a condition to reap the rewards of preparedness.

The day is here when maintenance should and shall receive the same consideration as production.

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Mechanical and Electrical Analyses of 40 inch Blooming Mill Screwdown

By F. D. EGAN*

IN the general electrification program for the Lackawanna Plant, our 40-in. blooming mill is being electrified, and all the steam and hydraulic drives are being replaced. The screwdown is at present electrically driven, but it will be necessary to rebuild this drive due to the speeding up of the balance of the mill. In laying out the new screwdown we have given much consideration to the arrangement of the gearing and the gear ratio, as effecting the WK^2 effect of the drive. Tests were made on the 40-in. blooming mill screwdown at Lackawanna to substantiate the conclusions drawn from our mechanical analysis. Later tests were run on other 40-in. blooming mill screwdowns in the corporation. It is the purpose of this paper to analyze these tests, and to draw conclusions regarding the arrangement of the gearing and gear ratio as effecting the WK^2.

Mechanical Analysis.

The present screwdown used on the Lackawanna 40-inch blooming mill is shown in Fig. 1. This drive has two reductions using mitre gears between the lay shaft and the screws. The total reduction is 5.72/1

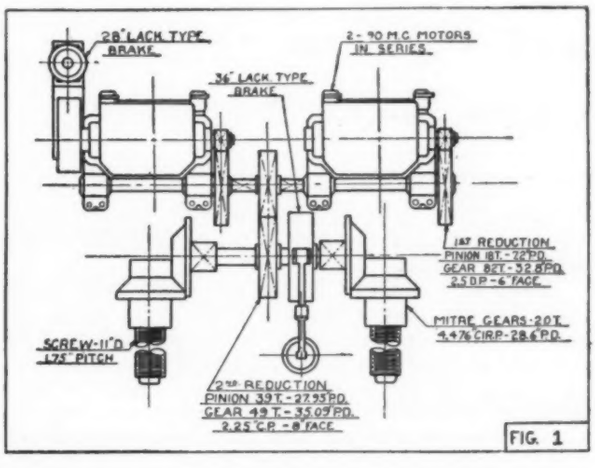


FIG. 1

with a corresponding screw travel of 5.90 feet per minute at a motor speed of 231 rpm., which is the full load speed of two Westinghouse 90 M.C. motors in series. The WK^2 effect of this drive was calculated and the results tabulated in Table No. 1.

The WK^2 effect when referred to the armature shafts is 1220 lb. ft.^{2} This drive consists of two Westinghouse 90 M.C. series motors connected in series across a 230-volt circuit, giving an equivalent HP. equal to that of one motor, an equivalent torque of twice that of one motor, and a speed curve slightly less than one-half the corresponding speed of a single motor. Two brakes are used on this drive, one located on the armature shaft of one of the motors, the second being located on the lay shaft. Both of these brakes are of the band type, designed to give the same braking effect up and down, and actuated by an ironclad solenoid. Both brakes are connected in series with the two motors.

In rebuilding this mill the old screwdown is to be replaced, and as the mill schedule is to be increased it was proposed to increase the speed of the screwdown by installing a drive having a lower gear ratio. The arrangement of the proposed drive was practically duplicate of the drive shown in Fig. 2, except that 90 M.C. motors were to be used in place of the 100 M.C. as shown in the sketch. The drive shown in Fig. 2 is operating in one of the 40-in. blooming mills in the corporation and is one of the drives referred to in the following tests.

This drive shown in Fig. 2 has two reductions, one between the motors and the lay shaft, the other in the bevel gears, giving a total reduction of 2.75/1 with a corresponding roll travel of 11.2 fpm. at a motor speed of 185 rpm. The WK^2 effect of this drive was calculated and the results tabulated in Table No. 2. The WK^2 effect when referred to the armature shaft is 12,416 lb. ft.^{2}

This screwdown as originally installed was driven

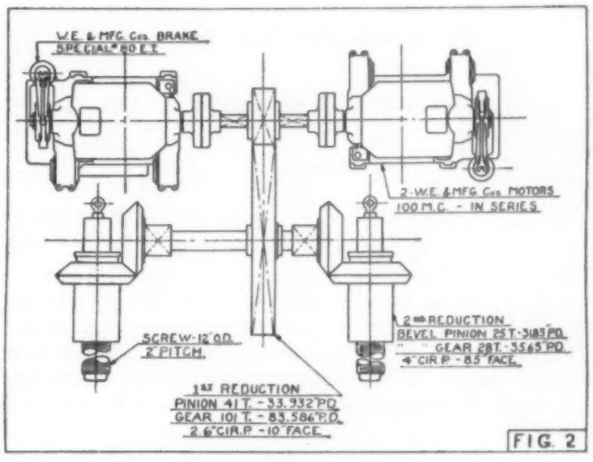


FIG. 2

by two Westinghouse 90 M.C. series motors connected in series across a 230-volt circuit. It was later found necessary to change this drive, using two Westinghouse 100 M.C. series motors connected in series across a 230-volt circuit. With this change it has still been found necessary to blow air into the motors to keep down the heating. It should be noted that this mill is compelled to roll quite a tonnage of slabs, necessitating a roll travel of as high as 30 inches up and down for a single pass.

The proposed screwdown as finally adopted is shown in Fig. 3. This drive has two reductions in addition to the reduction in the bevel gears, giving a total reduction of 6.33/1 with a corresponding roll travel of 6.06 feet per minute at a motor speed of 231 rpm. The WK^2 effect of this drive was calculated and the results tabulated in Table No. 3. The WK^2 effect when referred to the armature shaft is 1472 lbs. ft.$_2$

*Electrical Superintendent, Bethlehem Steel Company, Lackawanna, N. Y.

SCREW DOWN - 40" BLOOMING MILL

LACKAWANNA TABLE #1

2 - 90 M. C. MOTORS IN SERIES

	WT	DIA.	K	WK^2		WK^2 AT ARM. SPEED
2 - 90 M-G ARMATURES				670		
1 - BRAKE WHEEL	325	28"	.93	281		
2 - ARMATURE PINIONS	120	7.66"	.226	6		
				957		957
1st REDUCTION $\frac{82}{18}$ = 4.55		4.55^2 = 20.7				
2 - GEARS ON BACK AXLE	900	33.4"	1.10	1090		
1 - PINION ON BACK AXLE	680	29.36"	.98	650		
1 - SHAFT	1460	6.25"	.185	50		
				1790	20.7 =	86
2nd REDUCTION $\frac{49}{39}$ = 1.26		4.55 x 1.26 = 5.72				
			5.72^2 = 32.6			
1 - GEAR	870	36.52"	1.2	1250		
2 - BEVEL PINIONS	2300	32.75"	.625	900		
1 - SHAFT	817	7.00"	.206	35		
2 - BEVEL GEARS	3440	32.75"	.75	1935		
2 - SCREWS	7000	1.75"	.326	245		
1 - BRAKE WHEEL	638	36"	1.2	920		
				5785	32.6 =	$\frac{177}{1220}$

TRAVEL OF SCREW $231 \times \frac{18}{82} \times \frac{39}{49} \times \frac{1.75}{12}$ = 5.90 F.P.M.

MAX. SPEED DOWN FROM TEST $440 \times \frac{18}{82} \times \frac{39}{49} \times \frac{1.75}{12}$ = 11.2 F.P.M.

MAX. SPEED UP FROM TEST $540 \times \frac{18}{82} \times \frac{39}{49} \times \frac{1.75}{12}$ = 13.7 F.P.M.

The gearing on this drive is to be made with wider faces, resulting in a slightly higher WK^2 effect than our old drive.

This drive will consist of two Westinghouse 90 M.C. series motors connected in series across a 230-volt circuit. Two Cutler-Hammer 24-in. type M brakes are to be used, each mounted on an extension of the armature shafts, and connected in series with the two motors.

In order to analyze the above drives it will be necessary to calculate the accelerating torque, and the current necessary to develop the above torque.

From the mechanical arrangement of the different drives the data in Table No. 4 has been calculated. The first column applies to the original Lackawanna drive. The second column applies to the scheme proposed for Lackawanna. The third column applies to Fig. 2 and applies to one of the screwdowns operating in the corporation. The fourth and last column applies to the screwdown as finally arranged for this new mill.

The rate of acceleration was selected for the drive in the first column and rate of acceleration was then calculated for the other drives, to give an equal travel of roll in inches in each case. The last line of this table gives the ratio of the heating the motors would be expected to develop if it were possible to accelerate the drives at the values calculated. It will be noted that the drive with the lowest WK^2 gives the lowest heating value and the rest in the order of the value of their WK^2 effect.

From this analysis it was predicted that the drive with the low gear ratio and high WK^2 effect would be slower during the first three to four inches of travel and would overheat with recurrent burnouts.

Electrical Analysis.

In order to analyze the different types of screw-downs it was considered advisable to run tests on the

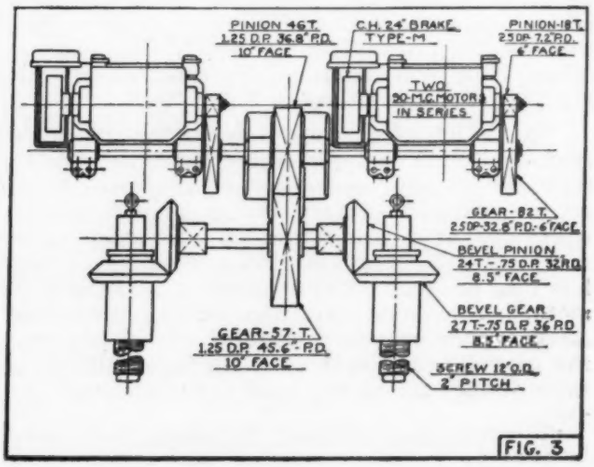


FIG. 3

SCREW DOWN - 40" BLOOMING MILL

TABLE #2

2 - 100 M. C. MOTORS IN SERIES

	WT	DIA.	K	WK^2	WK^2 AT ARM.
2 - 100 M. C. ARMATURES				1280	
2 - COUPLINGS	900		.5	225	
2 - BRAKE WHEELS	500		.8	320	
1 - PINION	1110	35½"	1.18	1550	
1 - SHART	305	6"	.146	6	
				3381	3381
1st REDUCTION $\frac{101}{41}$ = 2.46		2.46² = 6.06			
1 - INT. SLIP GEAR	6180	85"	2.83	49,500	
2 - BEVEL PINIONS	2300	33.27"	.64	945	
1 - SHAFT	1225	8.00"	.23	65	
				50,510 ÷ 6.06 =	8320
2nd REDUCTION $\frac{28}{25}$ = 1.12		2.46 x 1.12 = 2.75		2.75² = 7.55	
2 - BEVEL GEARS	6280	37.09"	.835	4400	
2 - SCREWS	7980	2" P	.352	980	
				5380 ÷ 7.55 =	715
					12,416

MOTOR SPEED 185 RPM.

TRAVEL OF SCREW $185 \times \frac{41}{101} \times \frac{25}{28} \times \frac{2}{12} = 11.2$ F.P.M.

MAX. SPEED UP FROM TEST $224 \times \frac{41}{101} \times \frac{25}{28} \times \frac{2}{12} = 13.5$ F.P.M.

MAX. SPEED DOWN FROM TEST $115 \times \frac{41}{101} \times \frac{25}{28} \times \frac{2}{12} = 6.95$ F.P.M.

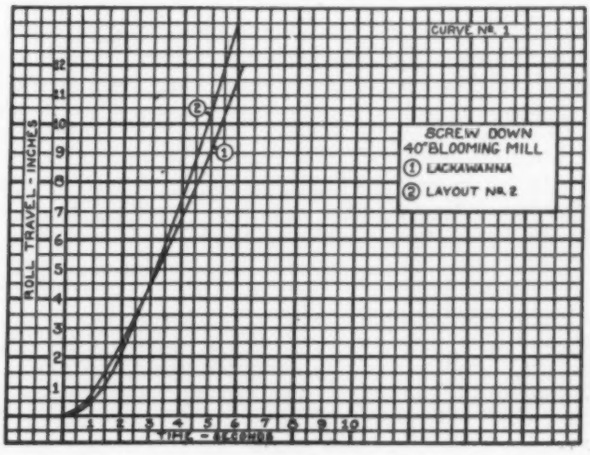
different drives. The purpose of these tests was to obtain data on the operation of different drives so that their characteristics could be compared. The tests were run by the Westinghouse Electric & Manufacturing Company's engineers, whom we wish to thank for their assistance.

A standard portable three-element oscillograph was used to obtain simultaneous records of motor current, motor speed, time and revolutions of the motor. A small portable homopolar generator was belted to the motor shaft, and its field excited to saturation from the 230-volt mill circuit.

The generated voltage is thus proportional to the speed of the generator, and the resulting curve obtained on the oscillograph film is an accurate indication of the speed. The motor current was recorded by the second oscillograph element. A pair of contacts was arranged to be closed once for each revolution of the motor and thus make a record of the motor revolutions for calibration purposes. The oscillograph is fitted with a special magnetic shutter, which when actuated from a dry cell and a seconds pendulum swinging through a pool of mercury, gives marks on the film at one-second intervals, and also serves as a zero line for the other curves.

The oscillograms were analyzed to determine values of roll travel in inches per second, and hp. seconds input corresponding to the travel of the rolls in inches for the two types of drives. The results are shown in Curves No. 1, No. 2, No. 3 and No. 4.

The following method was used to determine the distance time curves shown on curve sheet No. 1. Zero time was taken at the point where the speed curve left the zero line, and from this point time intervals were laid off in seconds. The areas were measured by a planimeter and the average speed in rpm. determined. From the average speed and the length



Curve 1.

SCREW DOWN 40" BLOOMING MILL

TABLE # 3

2 - 90 M. C. MOTORS IN SERIES

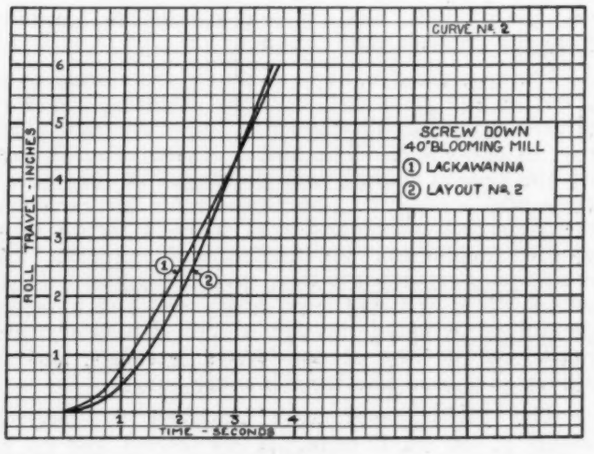
	WT	DIA.	K	WK^2	WK^2 AT ARM.
2 - 90 M. ARMATURES				670	
2 - C H 24" BRAKES	600	24"	.8	385	
2 - ARM. PINIONS	120	7.66"	.16	3	
				1058	1058
1st REDUCTION $\frac{82}{18}$ = 4.55			4.55^2 = 20.7		
2 - GEARS ON BACK AXLE	900	33.4"	1.10	1090	
1 - PINION ON BACK AXLE	1000	32.8"	1.09	1190	
1 - SHAFT	1700	6¼"	.185	58	
				2338 ÷ 20.7 =	133
2nd REDUCTION $\frac{57}{46}$ = 1.24			1.24 x 4.55 = 5.65		
			5.65^2 = 31.8		
1 - GEAR	1500	50.4"	1.69	4275	
2 - BEVEL PINIONS	2200	33.57"	.64	900	
1 - SHAFT	1125	8.00"	.233	66	
				5241 ÷ 31.8 =	165
3rd REDUCTION $\frac{27}{24}$ = 1.12			1.12 x 1.24 x 4.55 = 6.33		
			6.33^2 = 40		
2 - BEVEL GEARS	6400	37.39"	.835	4460	
2 - SCREWS	8000	2" P	.352	1000	
				5460 ÷ 40 =	136
					1472

TRAVEL OF SCREW - $231 \times \frac{18}{82} \times \frac{46}{57} \times \frac{24}{27} \times \frac{2}{12}$ = 6.06 F.P.M.

of the interval, the travel during the interval was calculated.

Curve Sheet No. 2 is the lower portion of Curve Sheet No. 1 magnified. From these curves we note that although the drive shown in Fig. 2 has a lower gear ratio and a higher free running speed than the drive shown in Fig. 1, yet it is slower during the first four inches of travel. Since the usual breakdown in a 40-in. blooming mill is about 2½ inches per pass the drive shown in Fig. 1 with the high gear ratio and lower free running speed is in reality the faster of the two during the working period.

The input to the motors driving the two types of screwdown was then calculated as follows: Taking a point where the current curve leaves the zero line as our zero point, we lay off one second intervals as before, and with a planimeter measure the area bounded by the curve, the one second line and the base line. Dividing this area by the base we get the average ordinate, from which we can obtain the current during this interval. This value multiplied by the line voltage and the time of the interval in seconds and divided by 746 gives us the hp. seconds input



Curve 2.

TABLE #4

	Present Lackawanna	Proposed Layout	Layout #2	Final Layout #3
MOTORS	2 - 90 M.C.	2 - 90 M.C.	2 - 100 M.C.	2 - 90 M.C
GEAR REDUCTION	5.72/1	2.75/1	2.75/1	6.33/1
ROLL TRAVEL FT./MIN.	5.90	14.1	11.2	6.06
ROLL TRAVEL PER REV. OF ARM = $\frac{P. \text{ OF SCREW}}{\text{GEAR RATIO}}$	.306	.728	.728	.316
WK^2 AT ARM. SHAFT	1220	11,416	12,416	1472
MOMENT OF INERTIA = $\frac{WK^2}{32.2}$	38	355	388	46
RATE OF ACCELERATION R.P.M./SEC.	200	84	84	194
ANGULAR ACCELERATION = $\frac{\text{RATE OF ACC.} \times 2\pi}{60}$	21	8.8	8.8	20.3
ACC. TORQUE = ANG. ACC. x MO. OF INERTIA	798	3120	3400	935
FRICTION TORQUE	520	520	520	520
TOTAL TORQUE	1318	3640	3920	1455
CURRENT BASED ON ONE HALF TOTAL TORQUE	260	520	510	280
CURRENT SQUARED	67,600	270,000	260,000	78,400
RATIO OF SQUARED CURRENT	1	4	3.88	1.16

NOTE: ABOVE TABLE BASED ON EQUAL TRAVEL OF ROLL IN INCHES

to the drive during the interval. In like manner the hp. seconds input was calculated for 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 seconds, for the two drives. These values can be compared to the corresponding roll travel during the same interval and the resultant curves shown on Curve Sheet No. 3 plotted.

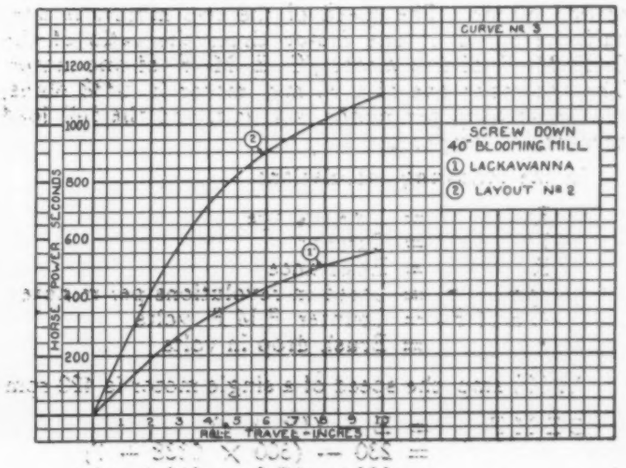
An analysis of this curve sheet shows that the screwdown with the low flywheel effect has a decided advantage over the screwdown having the higher value. For a corresponding travel in inches the one drive requires practically double the input in hp. seconds. This curve would indicate that the drive with the high flywheel effect will develop four times the heating of the drive with the low flywheel effect, as the heating is proportional to the current squared. Practice on the two drives indicates the same result.

If we examine the current curves of our old drive it will be seen that considerable plugging resistance has been used, as the peak current values do not rise to the same values for the different steps. It will also be noted that the speed curve does not leave the zero line for approximately ½ second after the current has started to flow. This indicates that the brakes are slow in releasing as well as too high a resistance value in the controller. This same solenoid type of brake is also slow in setting resulting in inaccurate stopping and making frequent plugging necessary. With the type of brake we are now installing we expect much quicker release and setting with a corresponding increase in the operating speed.

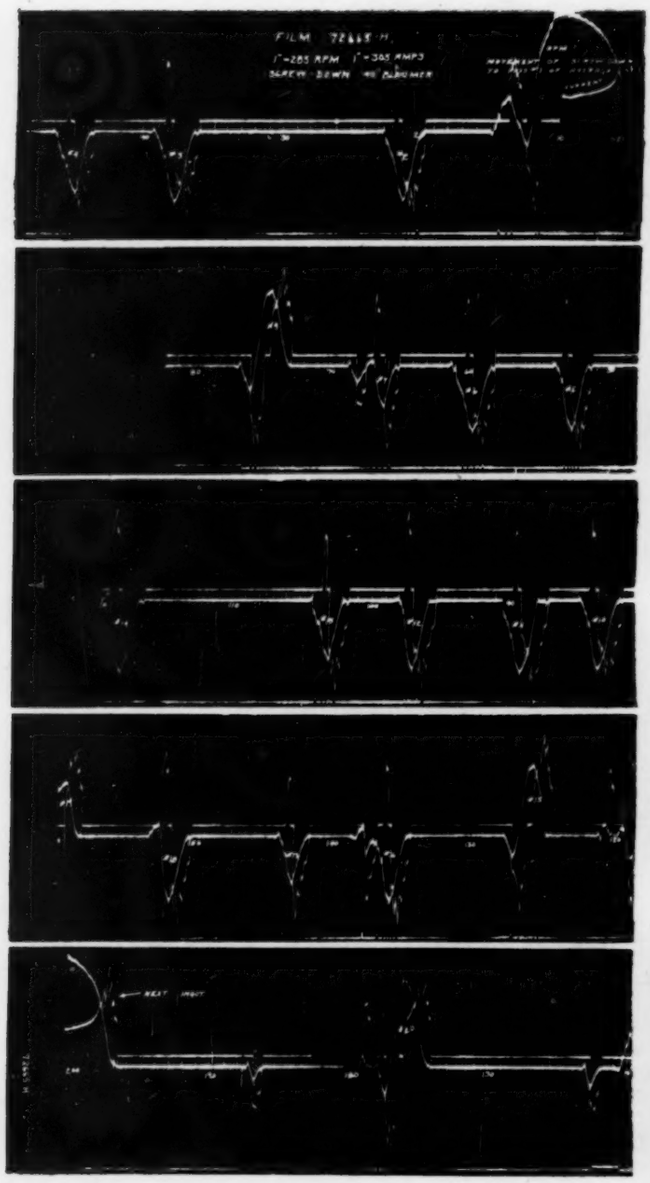
Resistance Calculation.

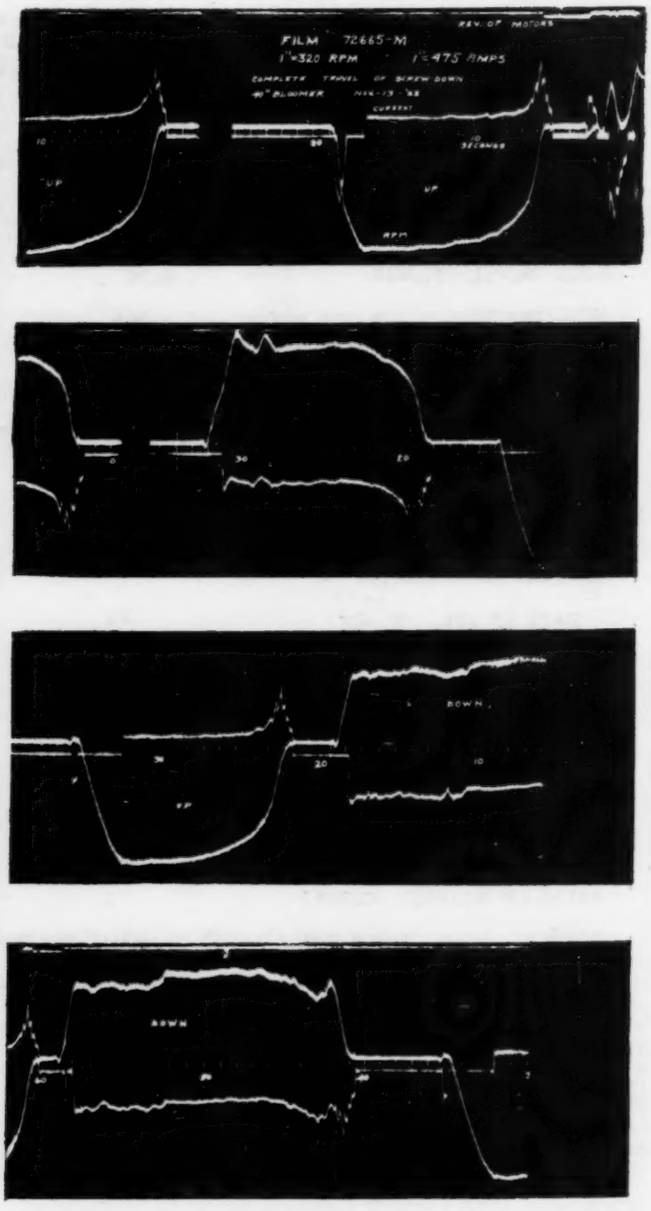
From the test curves it will be seen that the current peaks on our present screwdown average about 425 amps. In the new controller we will calculate the starting resistance to limit the maximum current on each step to 450 amps.

In calculating the starting resistance for this controller it will be necessary to calculate and plot a current rpm. curve of two 90 m.c. motors in series, operating on a 230-volt circuit with no external resistance in



Curve 3





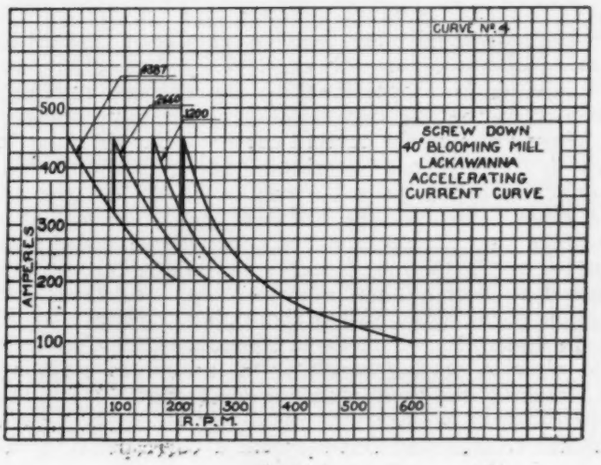
the circuit. It is known that the speed of two motors in series of 230 volts would be less than half the speed of one motor due to the additional resistance of the second motor. The speed of the two motors is one-half the speed of one motor times the ratio of the C. E. M. F. of two motors/C. E. M. F. of one motor. The hot resistance of a 90 m.c. motor is .0338 ohms, the brush drop per motor is 1 volt, and the full load current 360 amperes.

In the following calculations

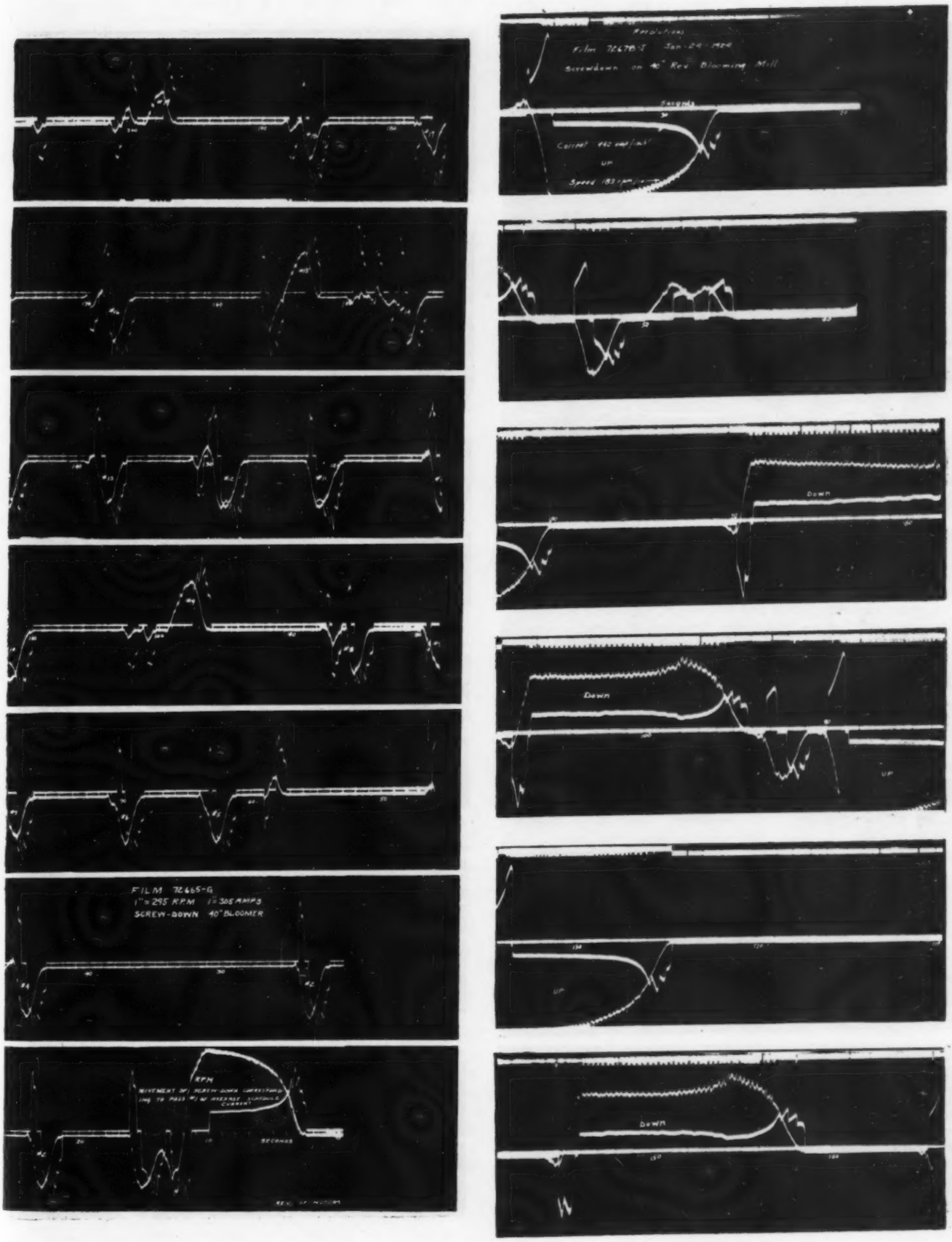
E	=	Line voltage
I	=	Current
R	=	Resistance
rpm.	=	Speed in revolutions per minute
C.E.M.F.	=	Counter E.M.F. volts
e	=	Brush drop in volts

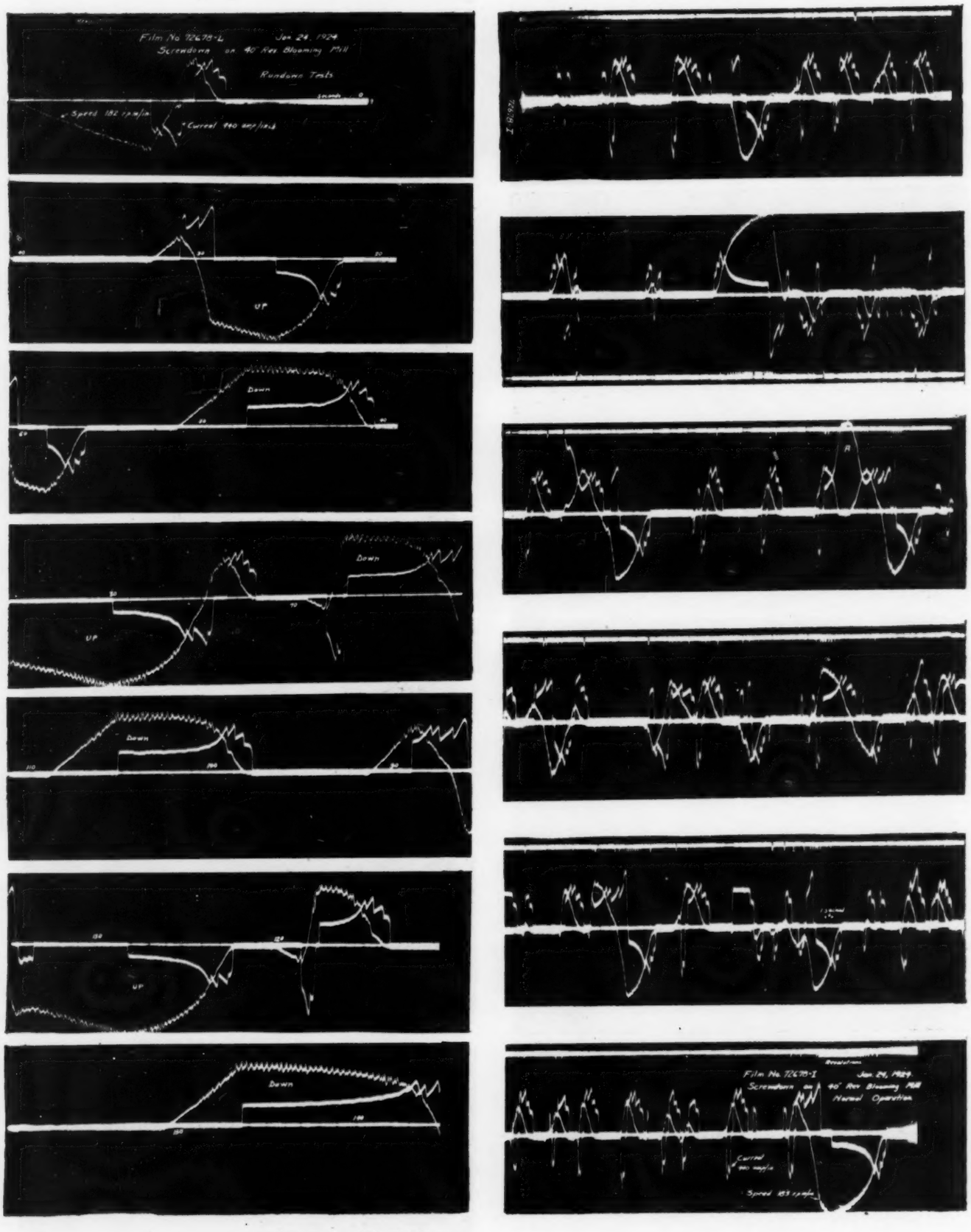
At 500 amp. the speed of a single motor is 420 rpm.

$$\text{C.E.M.F.} = \frac{E}{} - (IR + e)$$
$$= 230 - (500 \times .0338 + 1)$$
$$= 230 - 17.9 = 212.1 \text{ volts}$$



Curve 4.


Revolutions
Film 72678-I Jan-24-1924
Screwdown on 40" Rev. Blooming Mill
Seconds
Down
Down
FILM 72665-G
1" = 295 R.P.M. I = 305 AMPS.
SCREW-DOWN 40" BLOOMER
R.P.M.
SECONDS
Down


Film No. 72678-L Jan. 24, 1924
Screendown on 40" Rev. Blooming Mill
Random Tests
Speed 182 r.p.m.p.
Current 940 amps.
UP
Down
UP
Down
UP
Down
Film No. 72678-I Jan. 24, 1924
40" Rev. Blooming Mill
Normal Operation
Current
Speed 183 r.p.m.

C.E.M.F. of two motors $= 230 - (2 \times 17.9) = 194.2$ volts

$$\text{rpm. of two motors} = \frac{\text{rpm.} \times \text{C.E.M.F. of 2 motors}}{\text{C.E.M.F. of 1 motor}}$$

$$= \frac{420}{2} \times \frac{194.2}{212.1} = 192.5 \text{ rpm. at 500 A.}$$

The speed of the two motors in series was calculated for several values of current down to 125 amps and from these values the free running curve of the two motors in series with no external resistance was plotted on Curve Sheet No. 4.

Next the value of the starting resistance was determined as follows:

At standstill the drop across the two motors and the resistance will be 230 volts.

I R drop of the resistance $= E - 2\,(IR + e)$
$= 230 - 2\,(450 \times .0338 + 1)$
$= 197.6$ volts

$$\text{Resistance} = \frac{197.6}{450} = .4387 \text{ ohms}$$

Next the current rpm. curve was calculated with an external resistance of .4387 ohms in series with the two motors.

At 450 amps the speed will be zero, giving the starting point of the curve.

At 400 amps the speed of two motors without resistance is 217 rpm.

C.E.M.F. of two motors without resistance $= E - 2\,(IR + e)$
$= 230 - 29$
$= 201$ volts

C.E.M.F. of two motors with resistance $= E - [2\,(I\,R + e) + I\,Rr]$
$= 230 - 29 - 175.5$
$= 25.5$ volts

From the equation that

$$\text{Speed} = \frac{\text{C.E.M.F. of two motors} \times \text{free running speed}}{\text{C.E.M.F. of two motors with resistance}}$$

$$= \frac{25.5 \times 217}{201.0} = 27.5 \text{ rpm.}$$

In like manner values of rpm. of the two motors with .4387 ohms resistance in the circuit were calculated for different values of current and the curve for first step plotted on Curve Sheet No. 4.

The second step was next calculated to limit the current to 450 amperes maximum. The manner in which these values are most generally calculated is to assign arbitrary resistance values and then calculate the rpm. current curve using these values. If this curve does not satisfy, the resistance values may be reassigned and the curve recalculated. In this manner resistance values can soon be found that will give the desired acceleration curve.

Assume a resistance value of 0.2660 ohms for the second step.

At 450 amps the C.E.M.F. of two motors without external resistance will be as follows:

C.E.M.F. $= E - 2\,(I\,R + e)$
$= 230 - 2\,(450 \times .0338 + 1)$
$= 230 - 32.4 = 197.6$ volts

C.E.M.F. of two motors with an external resistance of 0.2660 ohms will be as follows:

C.E.M.F. $= E - [2(I\,R + e) + I\,Rr]$
$= 230 - 32.4 - 119.8 = 77.8$ volts

At 450 amps the speed of two motors without resistance is 203 rpm.

Speed of two motors with 0.2660 ohms will then be

$$\text{rpm.} = \frac{77.8}{197.6} \times 203 = 80 \text{ rpm.}$$

In like manner values of rpm. of the two motors with 0.2660 ohms resistance in the circuit were calculated for different values of current and the curve for the second step plotted on Curve Sheet No. 4.

Assuming a value of .1200 ohms resistance for the third step, the rpm. current curve for this step was calculated in like manner and plotted on Curve Sheet No. 4.

Discussion on this paper will appear in the August issue of Iron & Steel Engineer.

The Giant Power Survey of Pennsylvania

By JUDSON C. DICKERMAN*

IT is said that a little knowledge is a dangerous thing. My little knowledge of the iron and steel business therefore might be classed as putting me in a dangerous position in assuming to talk to such a mass of great knowledge of that industry as is before me. But if your greater knowledge will be kindly extended to me in supplying what I lack, then it will no longer be dangerous for me to talk to you about some of the things of which I know a little, which may become interesting to you. My excuse for being here is not more knowledge, but a possibly different point of view which may be interesting.

The iron and steel industry as we know it is one of our greatest examples of the expenditure of energy, mental, physical, but above all else, of energy derived from coal. This energy, manifested as high temperature heat and in considerable part converted into mechanical and electrical power, is extremely interesting to the engineers of the Giant Power Survey. The proper control and direction of this energy results in the quantity production of that material which is the first story of the material structure of our civilization.

*Assistant Director, Giant Power Survey, State of Pennsylvania.

We are obliged to think of iron and steel, widely distributed in large quantities, in great varieties of form and quality, as bearing the burden of that increased production of wealth per capita which has enabled our civilization to be built up to furnish the large measure of comfort now enjoyed by the mass of the people of civilized countries, and as furnishing a stout right arm for the man with a strong constructive sense to use in accomplishing great feats of service to mankind.

The Giant Power Survey idea is both a philosophy and a vision; a systematic study of facts and a far-reaching comprehensive plan. In the experience of most men, their activities are directed to making more profitable for their concern the particular operation or relatively limited group of operations to which each individual is assigned. The Giant Power Survey of Pennsylvania is intensely interested in profits also. The profits are those which can be widespread for the direct benefit of the community at large. In other words, our study has a definite social ideal, which causes us to cover wide fields in search of needs as well as of means to satisfy in the most helpful manner these needs. And these means, if they are to satisfy these needs, must be economical and based on the most enlightened planning and skillful management possible.

We feel that a very fundamental of any material civilization is increased non-wasteful production of useful and wanted goods. This increased production should be accompanied with increased comfort and satisfaction of the human beings by whose help it is brought about. The history of mankind, until the era of power factory production, was that the unaided strength of man could not wrest from nature enough of the materal of life to advance a whole group of individuals into conditions of comfort, convenience, and intellectual development. Such civilizations as did develop, were for a small part of the population, at the expense of depriving the great mass of much of the little they could produce.

But with the invention of mechanical power devices, beginning with sails on vessels, windmills, water wheels and finally the steam engine, man came to have power beyond himself, he could multiply his own muscles several or many times, and it became possible for real civilization to advance without crowding a goodly portion of the people below a fair standard of living. Because of the survival of the traditions of human relations dating back thousands of years, the benefits of power were not always fairly applied, but no one can dispute that the great mass of people in civilized countries today, where the use of power has developed, are living more comfortably and have a wider range of satisfaction of life than their ancestors of 200 years ago.

Think of the life of the hand power Chinaman, compared with the mechanical power Englishman. Yet the Chinaman has developed a considerable civilization in spots.

The development of the past few years in the generation and transmission of power as electricity, and in the means of efficiently and conveniently using electric power in both large and small installations, have opened up a new era.

While it is true in many industries, the ratio of cost of power to the total cost of production is a minor fraction, yet without adequate and reliable power the great volume of production would not be possible. So power is, after all, in a broad view, of extreme importance in our civilization and to our well-being.

The water wheel for centuries meant power available only alongside the flowing stream, with interruptions due to flood, drought, ice and trash, and definite limitations as to enlargement.

The steam engine permitted greater flexibility of location and size, being possible to operate wherever coal could be transported and some water was available. But the power could only be used as far as belts and shafting connected to the engine could be operated. Also the efficiency and cost of the power developed were many times cheaper in large units than small. Industry then was strongly concentrated near the big power sources and the social disadvantages of herding people together became manifest.

Now we can see as possible all the benefits of large scale production of power, centered where natural conditions make for the greatest economy and lowest cost, distributed to numerous consumers of power at great distances from the power stations, with such small differences in cost of the power actually available between the small consumer of a few horsepower and the big consumer of thousands as to be no serious handicap in developing industry and individual initiative.

Giant Power looks forward to tying together all economical sources of power, whether regular or more or less intermittent; as substitutes for the inefficient, small and poorly designed stations; connection to Giant Power Stations; to the establishment of a comprehensive and wide reaching network of transmission lines which will have the effect of a pool of power. It looks farther; it calls for facilities for electric power to be extended into districts not possible to serve, or which have not been served under our present system of smaller, independent systems with their higher costs.

The cheapening of costs by the economies of large stations and adequate transmission lines, by furnishing an outlet for otherwise wasted power, with lower cost power to the consumer, means an increase in volume and an increase in diversity of use which again tends to reduce the ultimate cost.

We all know that reduction in the cost of any useful commodity or service widens and diversifies the market, thus benefiting the producer as well as putting in the possession of consumers means for increased production of their lines.

One of the distinctive features of the Giant Power Survey is that the benefits of cheap and adequate power shall be rapidly and completely extended to the largest possible number of our people. The representatives of the public must take an active part, both to point out the needs and to aid in developing new ways of economically accomplishing this important social development. Does anyone fear that a state which can plan, provide for, and carry to completion a system of several thousand miles of vehicular highways costing $25,000 to $50,000 a mile, with an average daily transport of 50 vehicles per mile per hour, utilizing an average continuous power development of about 50 hp. hours per mile, cannot devise means through suitable encouragement of private enterprise or even if necessary by public resources, to furnish the transmission lines costing about $20,000 per mile to convey upwards of 100,000 hp. each? All that is needed is the realization of the possibilities in eco-

nomic service, and the great benefits to the public, and then ways will be found to accomplish it.

The tentative program of the Giant Power Survey in part is as follows:

1—Large sized central stations of 500,000 kw. capacity.

2—These stations to be located at or near the coal mines.

3—A trunk system of transmission lines, operating at 220,000 volts and possibly above that, with large capacity.

4—An integrated or adequately tied together transmission and distribution system.

5—The pretreatment before using as power plant fuel of all bituminous coal capable of yielding by-products of value.

6—Current distributed to the rural population.

7—Trunk line railroad electrification.

8—Reduction and equalization of rates consistent with the cheapening of costs by the economies to result from the other planks of the program.

9—The utilization of water powers whenever feasible.

10—Utilization of inferior portions of coal mined, reduction of waste in mining and possibly the marked reduction of the smoke nuisance through the operation of smokeless fuel production plants, in connection with the Giant Power stations.

Let us see how this program is related to the present iron and steel industry.

In the first place, we obtained much inspiration from a consideration of the development of the steel industry. In it we see an industry which has applied scientific engineering to the conservation of the fuel needed.

Not many years ago, your coke was produced with an utter loss of the oils, tars, ammonia and gas, which it has now been made a routine thing to recover and put to real usefulness, instead of polluting the atmosphere. The steel industry, consciously or not, looks at volatile bituminous coal, not as a mere source of simple Btu., but as a material capable of much higher orders of usefulness.

Again the steel industry is an excellent example of fuel conservation in its utilization of the formerly wasted blast furnace gas to develop power through gas engines. It has been the chief inspiration for the development of efficient and large sized internal combustion engines. Giant Power looks with longing at the 4,000-hp. gas engines of the steel industry, wishing it were possible to make them five or ten times larger, to compete with the steam turbo generators as the prime movers of its Giant Power station.

The Giant Power Survey is interested to learn that the efficiency in use of waste heat and by-products of coke manufacture has so far developed, as to permit of a large steel plant supplying all the heat and power needed to produce heavy steel, with the use of no other raw coal than is required to make coke for the blast furnace. We want to see our Giant Power stations producing the maximum of values from the coal by pretreating the coal by some method of distillation, resulting in cheaper power, as a similar treatment of coal in coke making has resulted in cheaper steel. In the period when first I took notice of large steel plants, back in 1900, when the electrical engineer was almost an unknown quantity in that business, certain marked characteristics were the numerous boiler plants scattered about the plants and the great rushes into the air of exhaust steam from the hosts of steam engines on the rolling mills and other places of much power use. To the engineer trained in New England ideas of fuel economy, this seemed a terrible waste. But, happily, that period of waste has largely gone. The electrical engineer has come into his own and by concentrating his power plants and utilizing electric drives, he has cheapened his operations and conserved his fuel energy very greatly. Giant Power wants to see this same result take place with the whole state as the works and even looks beyond state lines to include other states in its systematic development.

We understand, moreover, that steel works which undertake the manufacture of steel beyond the simpler, heavy forms must obtain power beyond that possible from the coal charged into the coke plant. We believe this power should come from the Giant Power System. The reserve power should be in Giant Power and not in idle equipment at the steel plant.

Again, we understand there are times, such as Sundays, when for good social reasons it is customary to stop all mechanical work possible, yet gas in large volume is produced but not needed. It cannot be stored economically. It is therefore almost always wasted. With the plant connected to a Giant Power station the gas engines could be operated at maximum efficiency, delivering power to the system. At the coal burning station, equivalent coal combustion would cease. In Pennsylvania, with so many steel plants, if all connected to a central station, it is possible the Sunday load of a Giant station might be eliminated altogether, giving a day's rest to a complete group of workers.

The general connection of the steel works to the Giant Power System, as we conceive it, would have the following advantages to the system and to the public interest:

1—Increase the load factor of the system.

2—Add somewhat to the diversity factor.

3—Increase the size of the power units to be added each year to the growing system, thus tending to make them cheaper per unit.

4—Be a source of power for the Giant Power System in period of light demand in the steel plants, while yet the blast furnaces and coke ovens were in operation producing surplus gas and other fuel.

On the part of the steel works, it would:

1—Reduce the amount of standby power equipment needed.

2—Simplify or assist in carrying the short time heavy peak loads.

3—Permit of operation of all power units at loads of maximum efficiency at all times.

4—Reduce the amount of new capital investment necessary to meet the demands of a growing business.

5—Purchase at lowest possible cost any current needed in excess of that produced from waste heat.

6—Cheaper power to the scattered quarries and mines producing the stone and coal required.

7—Removal of some of the density of traffic converging at the steel plants by reducing the carloads of coal now brought in to furnish power.

All of the above would reduce the cost of steel to the maker, reduce the cost of power to other consumers and thereby aid to that extent in maintaining the industrial supremacy of Pennsylvania while at the same time making it more possible to spread the comforts and help of electricity to small and scattered possible consumers.

From the foregoing you will readily see how the iron and steel industry is of interest to the staff of the Giant Power Survey and why the survey has its appeal to the progressive minded men of the steel industry. There are, of course, difficulties in the way of completely synchronizing the power facilities and requirements of steel plants with a Giant Power System. Perhaps the first to come to mind is the prevalence of 25-cycle energy in steel works, whereas any universal system will have to be on 60 cycles. The necessary adjustments are solvable by such men as are represented here when the full extent of the benefits to be derived are comprehended. We hope our friends of the steel industry will give their enthusiastic support to our program as a whole, for I can think of no body of industrialists who have a better background from which to visualize the great advantages of the fulfilment of the vision of Giant Power as I have partially and inadequately pictured it.

Calumet and Crawford Ave. Stations of the Commonwealth Edison Co. Chicago, Ill.

By W. F. SIMS*

THE rapid growth in the demand for electrical energy has necessitated large construction programs on the part of the central station companies throughout the country. This is particularly true in Chicago, and the installation of the last units in the Northwest and Fisk Street stations made it necessary to proceed with the design and construction of new generating stations in order to supply the ever-increasing demands for light and power on the system of the Commonwealth Edison Company.

Northwest station, located on the north branch of the Chicago River at Roscoe Street and California Avenue, about eight miles north and west of the loop, has a rated capacity of 165,000 kw. Fisk Street Station on the south branch, about three miles south and west, has 230,000 kw., and Quarry Street, just across the river from Fisk Street, has 84,000 kw.

Studies of the growth of the load indicated that additional generating capacity would be needed in the fall of 1921, and that for several years thereafter considerable additional capacity would be required. These studies showed that the first additions should be made in the southeastern part of the city, and that later additions would be required to reinforce the district supplied from Fisk Street and Quarry Street stations.

As the supply of water available for the condensers, as well as railroad connections for coal supply, determine the location of large stations, sites on the Calumet river and on the drainage canal were secured.

Calumet Station Location.

Calumet Station is located on the west bank of the Calumet River at 100th Street, and serves the needs of the rapidly growing industrial district in and around South Chicago, as well as tying into Fisk and Quarry Street stations, and later into the Crawford Avenue site.

The station, which has a capacity of 187,000 kw., was built in three sections, each accommodating two units of 30,000 kw. each (except the last, which is 37,000 kw.), and it was originally intended that there would be an interval of about a year, and possibly more, between sections.

The demand for energy, however, was such that before the first section was entirely completed, it was necessary to start the second, which was followed in the same way by the third section.

Excavation was started during the summer of 1920, and in spite of a very severe winter and the lockout of the building trades in the spring of 1921, the first unit was placed in service in December 1921, only a few weeks behind the original scheduled service date. The sixth and last unit was placed in service in December, 1923, slightly less than two years from the first unit.

In the installation of the fifth and sixth units, two turbo-generators and four boilers, with all of their auxiliaries, were erected in approximately three and one-half months. This is something of a record for this type of work.

The area of the property is about 43 acres and, as shown on the property plan, the station is so located as to provide ample facilities for the storage and handling of coal, and for adequate provision for cooling water intake and discharge connections to the river. Space immediately south of the station is used for the large system of underground conduits necessary for the cables required to transmit the energy generated.

General Layout.

The general plan of the building, which occupies a ground area of 548x288 feet, showed the arrangement and relative proportions of the four main parts of the station. The boiler house, located on the north side of the building, is 142 feet in width; next to this is the turbine room, 55 feet wide; then the 25-foot transformer house and, on the south side, the switch house, 62 feet wide.

The general architectural treatment is shown in the next two pictures, the first being a perspective drawing made by the architects during the preparation of the plans, and the second a photograph of the completed building, which gives an indication of the heights and space occupied by the various parts of the plant.

*Engineer, Commonwealth Edison Company, Chicago, Ill.

In describing this station, the coal supply, with its preparation and handling equipment, will be covered first and then in logical order, the boiler house and equipment, the turbine room, the switchhouse and, lastly, the conduit system in which the cables for

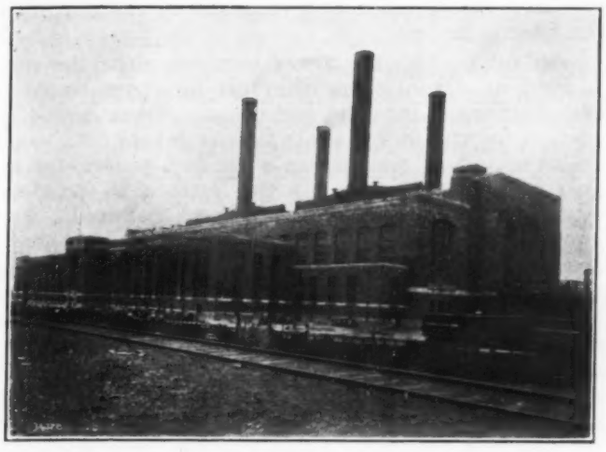


FIG. 1.

transmitting the energy are installed. This method has been used in showing visitors through the station and has proven very effective in giving a comprehensive idea of the station as a whole.

Coal Handling Equipment.

In the first two sections of the plant the design of the coal handling plant provided for bringing the coal cars into the train shed below the boiler room, at the general ground level. Three grab bucket cranes have been installed for unloading the coal, which can either be dumped into storage pits below for future reclaiming, or onto a longitudinal conveyor through traveling hoppers. This belt discharges into the coal preparation plant in the basement at the east end of the boiler house. When the third section was designed it was found that greater economy and more rapid

FIG. 2.

handling of coal could be secured by the installation of a car dumper. This was located opposite the northeast corner of the plant, and an inclined belt conveyor installed to carry the coal to the coal preparation plant. The combination of these two means of handling the fuel makes a very flexible arrangement and insures against delay in the coal supply in the event of breakdown of apparatus.

The car dumper is of the standard type of this form of apparatus. A car is run onto the dumper track by means of a motor-operated car puller. The closing of a switch causes a clamping device to lock the car in position, after which the dumper is slowly rotated until the car is turned upside down and the coal dumped into a hopper which discharges into the inclined conveyor.

The coal preparation plant consists of two coal breakers, which break up the lumps and discharge onto conveyors, which may in turn discharge onto either of two bucket elevators. Coal which has not been properly sized by the breakers is conveyed to a crusher which also discharges to these elevators. The elevators dump the coal into receiving hoppers in the upper part of the east end of the boiler house, from which the coal passes to the bunkers over each row of boilers, on two longitudinal belt conveyors. The coal is fed to the stokers through rectangular spots, fitted with baffle plates to insure an even distribution

FIG. 3.

over the entire width of the chain grate stokers. The ash is dumped from the stokers into ash hoppers back of the boilers, below the boiler room floor, and from there is discharged through pneumatically operated gates into cars on the ash tracks paralleling the coal tracks in the boiler room basement.

Boiler Plant.

The main boiler room floor is about 30 feet above the general property grade, and is arranged with a longitudinal firing aisle, with a row of boilers along each side. Eighteen B & W boilers, each with 15,000 sq. ft. heating surface, have been installed, with space for future installation of two additional boilers. The boilers are designed for 350 lb. pressure and 250 deg. superheat, and are normally operated at 325 lb. Economizers are built integral with the boilers.

Each boiler is equipped with two forced draft fans and one induced draft fan, all driven by variable speed a.c. motors controlled from push buttons mounted at the front of the boilers near the draft gauges. The chain grate stokers are driven by d.c. motors with a 4 to 1 speed range, and their drum controllers are mounted near the draft fan controls.

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The flue gases discharge into four stacks 16 feet in diameter and 167 feet above the grates. Provision has been made for the future construction of two additional stacks.

Feed Water System.

Four boiler feed pumps, one motor-driven, and three turbine-driven, have been installed for each pair of units. These pumps, together with the feed water heaters (one closed and one open for each unit), the steam separators, service pumps, water filters, water softening plant, air compressor, etc., are located in the pump room, which is an alcove off of the north side of the turbine room basement, below the boiler room.

The discharge from the condensate pump passes through a closed heater into which steam is bled from the main turbine at about atmospheric pressure. The feed water then passes into an open heater into which the exhaust steam from the steam driven auxiliaries and the discharge from the steam traps is fed, and which raises the temperature to about 175 deg. F. Make up water is carried in a hot water reservoir which receives the gland leakage, and the overflow from the open heater. The level in this reservoir is maintained by the admission of treated, filtered water under float control. A drop in the water level in the open heater causes a float to open a valve in the line between the hot water and the condenser hot well, and make up water is drawn over by the vacuum. A further drop in the level in the open heater admits filtered water direct to the heater. The discharge from the feed pumps passes through the economizers to the boilers. The supply to the boilers is governed by feed water regulators.

Main Units and Condensers.

The six turbo-generators are installed in one row, with their shafts parallel to the longitudinal axis of the turbine room. Unit No. 1 is a Westinghouse tandem compound machine rated at 30,000 kw., 1200 rpm. Units No. 2 to No. 5 inclusive are General Electric machines rated at 30,000 kw., 1800 rpm., and No. 6 is a Westinghouse turbine of 37,000 kw. capacity, 1200 rpm. All generators are 12,000-volt, 60-cycle machines, designed for 85 per cent power factor and have an inherent reactance of about 14 per cent. Generators No. 1 to No. 5 inclusive are rated at 35,300 kva., and No. 6 at 43,500 kva.

The condensers are of the surface type with 52,000 sq. ft. of surface. Cooling water is supplied from the Calumet river, and passes through motor-driven revolving screens into an open flume connecting with tunnels under the turbine room basement into which the circulating pump suction pipes are connected.

Units No. 1 and No. 2 have one circulating pump each, driven by 800-hp. variable speed motors with four steps, 66 per cent, 80 per cent, 88 per cent, and full speed. The other four units each have two circulating pumps driven by 350-hp. motors with the same speed range. This arrangement permits the maintaining of an approximately constant temperature of the condensate by varying the amount of cooling water as its temperature changes during the different seasons of the year. The discharge from the condensers passes into the discharge tunnel which opens into a flume paralleling the intake flume. On account of the fact that the direction of flow of the river is subject to change, diversion gates have been installed at the crib house, so that the intake may always be on the upstream, and the discharge on the downstream side.

Both steam and motor-driven condensate and vacuum pumps have been installed. The former are used for emergencies and to assist in the control of the heat balance.

Air for cooling the generators can either be recirculated or drawn from the turbine room basement and discharged into the pump room, from which the suction for the forced draft fans is taken. Air washers are used in connection with five generators and an air cooler with one. In the latter case the closed system of recirculation of air must be used. Each generator has 10 temperature coils imbedded in the armature slots between the coils, and the connections are brought out to terminal boards. The three hottest coils are selected by test, and these are connected to temperature indicators in the operating gallery.

The generators are Y connected with all three neutral leads brought out, and a current transformer is connected in each lead before they are brought to the common neutral. These current transformers, in connection with a similar set in the generator leads at the switchhouse end, are used to operate a system of balanced relays. In case of a fault in the armature windings or in the connections to the switchhouse, the unbalanced secondary current will cause these relays to operate and open the bus switches, the neutral switch, if closed, and after this open the field switch.

The excitation is from individual shaft driven exciters, and is regulated both by motor-operated main field rheostats and motor-operated exciter field rheostats, which with the field switches and the governors are controlled from the operating gallery. A double-throw switch has been installed in the field leads of each generator, which permits of reserve excitation being supplied from a storage battery and motor generators in the event of trouble with the shaft driven exciter.

The main generator leads, which are two 1,250,000 c.m. varnished cambric braided cables per phase, are carried in concrete compartments across the ceiling of the turbine room basement into the transformer house, where they drop down to the ceiling of the switchhouse basement. The 1650-ampere ⅛-ohm generator reactors are located on the first floor and the generator leads are brought up through bushings in the floor and connected to the bottom terminal of the reactors. The current transformers for instruments and for balanced relays are connected in the copper bar connections between the reactors and the generator switches.

Switchhouse.

The switchhouse is four stories in height, and was designed for the isolated phase arrangement of busses. The electrical equipment occupies the basement and the first three floors, and the fourth floor is occupied by offices, cafeteria, emergency bedrooms, etc.

The busses are carried on three longitudinal concrete walls spaced 16 feet in the first section, and 17 ft. 6 in. in the second section, with barrier walls midway between these bus walls on the oil pot and reactor floors. The busses and connections of each phase are carried on separate walls and all tributaries to the busses, such as outgoing lines, generator leads and connections to auxiliary power busses are protected by current limiting reactors before the three

phases are brought to a common run. With this arrangement, a bus fault or a switch failure can only cause a short to ground where the fault current is limited by the generator neutral resistance, which is three ohms, and makes the possibility of a phase to phase short, where the fault current is only limited by the reactance of the generators, very remote.

There are two sets of main busses, each divided into three sections, and the two busses are connected near one end by two 1-ohm, 1000-ampere reactors in series. It is planned to install later a similar reactance tie at the opposite end, and possibly to install reactors between the sections of each bus when operating conditions indicate the necessity for such arrangement. The generators may be connected to either main bus, and are arranged so that there are two units per section. All outgoing 12,000-volt lines are connected to short line busses, which may be connected to either main bus by 2,000-ampere group switches. There are usually three, but in a few cases four, lines on each line bus, connected through 700-ampere switches.

The main busses extend the entire length of the switch house, and are installed in concrete compartments on either side of the bus walls, at the ceiling of the first floor, and the line busses are installed in a similar manner at the ceiling of the second floor. The oil circuit breakers are installed in separate compartments on the second floor with remote controlled disconnective switches in compartments above, and are operated through a system of rods and bell cranks by mechanisms installed on the third floor.

Each line is connected through a set of 450-ampere ½-ohm reactors which, with the generator and bus tie reactors, are installed in concrete compartments on the first floor. The disconnective switches on the line side of the line breakers are installed in the basement, and are connected between the reactors and the cable terminals. These disconnective switches are operated from the mechanism floor simultaneously with the disconnectives on the bus side of the breakers, which are mounted on the second floor. These switches are of

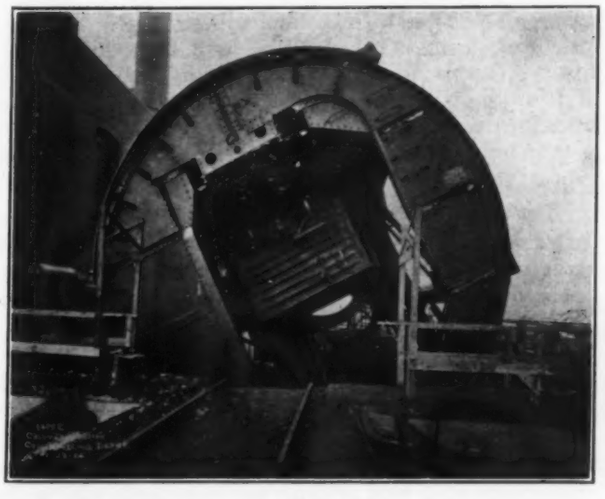

FIG. 4.

the double-throw type, and the back contacts are connected to high voltage cables which are carried through fibre ducts in the bus walls to double throw knife switches, mounted in asbestos cabinets on the mechanism floor. The upper clips to these switches are connected to the test bus, and the lower clips to a ground bus. By this arrangement it is possible by remote control to either ground the line or connect it for testing.

The disconnective switches may be operated manually, or automatically by the switch mechanism, and are so interlocked that when manually operated their position can be changed only when the oil circuit breaker is open, and when operated automatically they are closed ahead of, and opened after, the breakers.

Conduit System.

South of the switchhouse there are five 16-duct conduit lines for carrying the outgoing cables. The manholes and the duct runs to the switchhouse are so arranged that if it becomes necessary to transfer a cable from one section of bus to another, it can be done by a simple cable cut over in a manhole, and eliminates the necessity for any longitudinal cable runs in the switchhouse basement.

Operating Gallery.

The operating gallery is located in the fourth floor of the transformer house, overlooking the turbine room at the center of the building. The controls

FIG. 5.

for the generator switches, group switches, field rheostats, etc., are mounted on a bench board in the north side of the gallery with all generator and bus instruments and relays on vertical panels back of the bench board with a three-foot aisle between the two boards. The line control board on which are mounted the line switch control and the line instruments and relays is on the south side of the gallery. All control and operating circuits operate at 230 volts from the operating and reserve excitation storage battery.

Auxiliary Power System.

With the exception of the turbine driven boiler feed pumps, one house service pump and a few condensate and vacuum pumps, all station auxiliaries are motor driven. The stokers are driven by 230-volt, d.c. motors. All others motors below 100-hp. are 440 volts and all above 100 hp. are 2300 volt a.c. All 2300-volt motors and the 440-volt forced draft motors are controlled from push button stations, including the speed control of the variable speed motors. The closing of the starting circuit closes the switch at the 2300-volt power center and starts the variable speed motors on

the first step of the drum controller, and the speed is brought to the desired amount by manipulation of the speed control buttons. Operation of the stop button opens the switch and automatically returns the controller to the starting position. In the case of constant speed motors of the squirrel cage type, the operation of the starting button closes the motor switch directly across the 2300-volt busses, and starts the motor at full voltage. Motors as large as 350 hp. are started in this manner. In the event of a drop in voltage below 50 per cent of normal for two seconds, low voltage relays on the variable speed motors return the controllers to the starting position. All switches remain closed and upon the return of pressure both variable and constant speed motors come up as the voltage returns.

Power for the auxiliaries and for station lighting is supplied to the transformers from a 12,000-volt auxiliary power bus to which are connected three 4,000-kva., 2300-volt, two 2,000-kva., 440-volt, and two 230-volt transformers, the latter being for lighting service. One transformer of each size is for reserve. This power bus is connected to the main station busses through the bus tie reactors, which as previously noted, consists of two sets of one ohm reactors in series with a switch between the sets. The auxiliary power connections are made on either side of this switch. This arrangement was chosen in order that in the event of trouble on either bus there would be a reactor between it and the auxiliary power system and would lessen the probability of interruption of the power supply.

The secondaries of the 2300-volt transformers are connected to the 2300-volt switching center in the transformer house at the turbine room floor level, in which all switches for the 2300-volt motors are located. The 440-volt and lighting transformers are connected to main distribution switchboards, with local distribution boards in various parts of the station.

The lighting system is so laid out that in the event of failure of the normal a.c. supply certain emergency circuits are automatically thrown over to the battery.

Tie Lines to Other Stations.

Energy is transmitted from Calumet Station to other stations on the system by eight 22,000 and 33,000 volt tie lines. Each of these lines is fed through a 15,000-kva. transformer connected through 800-ampere reactors to the main busses by 2,000-ampere switches. These transformers, together with the auxiliary power transformers, are located in separate compartments in the transformer house at the level of the turbine room basement, from which they are separated by rolling steel shutters. Normal access to these compartments is through doorways from a corridor in the transformer house.

Crawford Avenue Station.

The Crawford Avenue Station, which is now under construction, is located on the north bank of the drainage canal on the west side of Crawford Avenue.

The general layout of the plant is somewhat similar to Calumet Station, but differs from it in a number of important details.

The coal preparation and handling plant is outside of the building, and all handling of storage coal will be done by a traveling bridge, instead of by locomotive cranes, as is the case at the other stations, and coal will be taken into the building by inclined conveyors.

The boiler house is arranged with transverse firing aisles, with five boilers per unit, with adequate cross-over connections between rows. The boilers are designed for 575 lbs. per sq. in., operating pressure, and one boiler of each unit will be arranged for reheating the steam after it has passed through the high pressure element of the turbine. Chain grate stokers and both forced and induced draft fans will be used. The heating of the feed water will be done by bleeding from the main turbines.

The initial installation will consist of three multiple unit turbo-generators with the high and low pressure elements on separate shafts, each with a separate generator, which will be operated together as a single unit. There will be one 50,000-kw. Parsons unit, one 60,000-kw. General Electric and one 50,000-kw. Westinghouse. The former will be a three element machine and the other two, two elements each.

Both the General Electric and the Westinghouse units will have an exciter on one shaft, and a 2500-kva. 2300-volt alternator for auxiliary power supply on the other shaft. The generator will be cooled by recirculated air with air coolers. All generators are 12,000-volt, 60-cycle machines.

The switchhouse is of the isolated phase type, similar to Calumet, but with two walls, with a working space between them, for each phase.

Power for the station auxiliaries will be supplied from transformers fed from the main busses, and also from the shaft driven alternators. Each alternator will be connected to a separate bus from which power for all of the essential auxiliaries of the unit will be normally supplied. During the period of starting a unit, its auxiliaries will be fed from the transformer bus, and when the machine is up to speed, will be thrown over to the unit bus. This arrangement provides a supply of energy for the important auxiliaries that is independent of system disturbances, and also has the advantage of the high efficiency of the main units. The transformer bus will normally carry the less important auxiliaries and will be available as a reserve supply to the turbine auxiliaries in the event of trouble on the shaft driven alternators. Sufficient transformer capacity is provided for supplying one unit in an emergency and for starting another, in addition to the normal load on the transformers.

The transformers for tie lines to other stations are installed in an outdoor transmission station. This structure is built of reinforced concrete, designed to harmonize with the architecture of the main buildings. Facilities for handling, purifying and storing transformer oil are provided in a building constructed as a part of the structure. The initial installation will consist of five 15,000-kva. transformers with space for future additions.

It is difficult to predict the ultimate capacity of this plant, as it will depend not only upon the growth of the system, but also upon the future development of the capacity of turbo-generators. The building, one-half of which is now being constructed, is designed to accommodate at least eight units of not less than 50,000 kw. capacity each. It is probable, however, that it will be larger, rather than smaller, than these figures indicate.

Decisions of the Public Service Commission of the Commonwealth of Pennsylvania Relative to Rates of Electric Light and Power Companies

By F. HERBERT SNOW*

I have endeavored in the presentation of the subject assigned to me to touch upon the salient features of commission's decisions affecting electric light and power rates. Out of many scores of such cases, I have selected 10 cases as types, where contracts, rules and regulations, demand, minimum of service charges, valuations, classification and miscellaneous cases featured the commission's decisions. Such a resume will, in my opinion, afford a good general understanding of the law and its interpretation by Appellate Courts and the practice of the Public Service Commission, at the end of its first 10 years' existence.

Contract.

William A. Allen, et. al. vs. Boyertown Electric Company (No. 538 C-2052) Reported February 25, 1919.

"William A. Allen and three other citizens of Boyertown, Berks County, filed a complaint alleging that the increased rates of the Boyertown Electric Company published and posted to become effective May 1, 1918, are excessive, unjust, and unreasonable; that the service by reason of frequent interruptions is inadequate; and that current for light and power is furnished to some consumers at a lower rate than that specified in the published tariff.

"Respondent in its answer justified the increase of rates in its schedule on the ground that it is compelled to pay the Metropolitan Edison Company from which it obtains practically all its supply a material advance in the rate charged for current, and because there has been an abnormal increase in the cost of labor and materials within the past few years. It denied any inadequacy in the service, and admitted that under a former management contracts were made with some of the larger consumers under which lower rates have been charged than those set forth in its new tariff. And it was further averred that all of these contracts except two have expired, and that where the contract ceases or has ceased the parties must pay the regularly established rates under the tariff."

Held:

"The principle involved in the issue here raised has been passed upon recently in several cases by this Commission and by the Supreme Court of the State. In Ben Avon v. Ohio Valley Water Co., P. U. R. 1917, C, 390, it was held by this Commission that all contracts prescribing rates for service, whether for a definite or indefinite period, do not preclude the Commission from determining what are just and reasonable rates. The Supreme Court in Leiper v. B. & O. R. Co. 262, Pa. 328, uses this language:

> 'There seems to be no difference in principle between the case of a contract indeterminate and one that is determinate, nor is there any difference in principle between a contract with a borough, with a corporation, or with an individual. Any contract of this character, whether for a definite or indefinite period, must give away when its terms conflict with the rates fixed in the method prescribed by the Public Service Act of 1913.'

"In the case of V. & S. Bottle Co., v. Mountain Gas. Co., 261 Pa. P. U. R. 523, 104 Atl. 667, wherein it was passing upon a contract between a public utility and an individual, prescribing rates for a definite period, the Supreme Court held that such contract became inoperative from and after the effective date of the Public Service Company Law.

"These decisions of our highest court bear directly upon the point here in issue. Under this interpretation a contract rate for service cannot be held to be valid where there is an express statute requiring a public utility to charge and collect rates for its service in accordance with those prescribed in its regularly published tariff. An order will therefore be made directing the respondent to cancel forthwith all rate contracts which are in conflict with the schedule of rates and to charge all consumers only the rates established under its duly authorized tariff."

As to the reasonableness of the rates themselves:

Held:

"From the position taken by respondent in defending its action it would appear that the tariff under attack was filed to provide an emergency rate to continue in effect at least during the period of the high prices recently prevailing. Counsel for respondent so maintained in his brief. This in substance is implying that when the cost of labor and materials resume a normal and stabilized level there will be a revision of rates filed under a new tariff. The Commission accordingly finds under circumstances now controlling that the complaint should be dismissed with the privilege accorded to complainants to file a new complaint, if they so desire, should the present rates be continued when expenses for operation and plant maintenance have fallen sufficiently to indicate that the net earnings of the respondent may show a material increase per annum.

"An order will issue requiring respondent to annul all contracts prescribing rates for service at variance with the proposed tariff within 30 days after receipt of this notice, and dismissing this complaint with respect to the feature of rates without prejudice."

Classification.

Slate Belt Electric Street Railway Company vs. The Pennsylvania Utilities Company (No. 625 C-2311) Reported August 12, 1919.

Paper presented before the A. I. & S. E. E., House of Representatives, State Capitol, Harrisburg, Pa., Friday evening, May 2, 1924.

*Chief of Bureau of Engineering, Public Service Commission.

"The Slate Belt Electric Street Railway Company purchases power from and is dependent for it upon the Pennsylvania Utilities Company, the respondent. To become thereafter effective on December 15, 1917, the respondent filed with this Commission a supplemental tariff in a form which has now become generally known as a 'Coal Clause' which provided that for 8 cents increase in the per ton price of coal over $2.70 (the base price) an additional sum should be paid by consumer at the rate of $0.0001 per kilowatt hour. By the same ratio a decrease in the cost of coal was to be followed by a decrease in the amount charged for current. On refusal by complainant, because of an alleged contract fixing for a definite period the rates for electric service, to pay the increases proposed in the coal clause, the respondent threatened to cut off service, whereupon the complainant filed a bill in equity in the Court of Common Pleas of Northampton County, setting forth its contract rights and claim for an injunction. The Court held 'the law has been established in Pennsylvania that a court of equity has no jurisdiction since the passage of the Public Service Company Act to determine the validity of a contract made by a public service company with a consumer. Such questions are for the determination of the Public Service Commission in the first instance and under the ruling of the court we would be compelled to dissolve the injunction and dismiss the bills'.'

So the matter came before the Public Service Commission.

"The basic contention of the complainant as averred and claimed to have been established by evidence is that a contract was entered into between complainant and respondent, or with a constituent company of respondent, to run for the period of 10 years, which had not then expired and its terms the respondent was obligated to continue to furnish complaintant with power at these contract rates which were less than those prescribed by the filed tariffs, to the extent and by the amount of the increase called for by the coal clause.

"It was further alleged and claimed to have been proven that a valuable consideration supported the contract, to wit, an easement or right of way in certain real estate, being a line of poles for transmission wires owned by complainant and located along the latter's railway.

"It appeared by the testimony that the complainant was at one time greatly in arrears to respondent on payment for electric power in an amount which on June 1st, 1916, was about $12,000, but which was reduced near the end of that year to $10,000. This arrearage continued at the latter sum until the period when the coal clause was effective. The complainant met the urgency of respondent for payment by turning over some of its less useful property and agreeing thereafter to pay $100 per day (the amount of power consumed averaging about $75 per day at the coal clause rate) until the arrearages were made up. Having in this way ultimately on April 27th, 1918, satisfied respondent's claim, complainant refused to continue to pay the increase (coal clause rate), alleging it had therefore paid in excess of the contract because of respondent's threats to cut off service upon which it was wholly dependent, and it now demands reparation in the sum of $2,669.31, thus asserted to have been overpaid.

"Respondent on the other hand contended that the 10-year contract was independent of the right of way conveyance, that it prescribed the same rates for service then charged to the other power consumers, that it was broken by complainant's failure to pay, that the new agreement superseded it when complainant began the payment of $100 per day which included rates covered by the coal clause, and that the case cannot be distinguished on principle referred to—Bottle Company vs. Mountain Gas Company, 261 Pa. 523; Klein-Logan Co. vs. Light Company, 261 Pa. 526; Leiper vs. Railroad Company, 262 Pa., 328.

"The complainant during the hearings and at arguments asserted that the coal clause was not a legal tariff fixing a rate in that it was not prepared in compliance with the Public Service Company Law, that it was indefinite and uncertain as to terms; that at most it provided a method by which the rate might be determined rather than prescribing one as is required of a legal tariff."

Held:

"It is our view that this Commission's jurisdiction attaches because the complaint involves the reasonableness of rates. The rates which any utility may charge for service which it renders must be filed rates, posted and published as required by law. Our inquiry then is directed towards determining whether those rates are properly drafted and filed, for obviously if they are not they are not legal rates; and whether, if legally filed, they are just and reasonable and not unreasonably preferential or unjustly discriminatory.

"For this Commission to substitute some other standards, for instance, private contracts in which one or the other of the parties had obtained an advantage, or in which the consumer was obligated to pay more or less than others in the same class not under contract, would be to read into the public service company law provisions not included in it, and open the door to the widest opportunity for the practice of discrimination and allowance of preferences.

"We have held in numerous cases where we have discussed at some length the substantial and underlying reasons for the rule, that rates, except perhaps in some instances those between utilities and municipalities which are covered by special provision of our Act, cannot now be based upon contract, but must at all times stand the test of what is just and reasonable. It would, therefore, be futile and perhaps usurpant of the functions of some other tribunals, for us to attempt to determine whether the 10-year contract was supported by the conveyance of a valuable transmission line, as claimed by the complainant but denied by the respondent, or whether the 10-year contract was breached by the act of either of the parties. The only questions are: Whether if such a contract exists, as claimed by the complainant, we are, because of it, precluded from inquiring into and determining the reasonableness of the filed rates which are objected to, and whether the filed rates are just and reasonable? To the first, following judicial guidance, we must make answer, we are not. As we have on other occasions said, a contract made prior to the Public Service Company Law may be some evidence of the value of the service and as such is entitled to consideration in determining the reasonableness of rates under attack. It was received in evidence for the purpose of aiding us in the determination of that

question, but it is a far different and unsupportable regulatory proposition to argue that such contract bars us from reaching a conclusion with respect to what is a just and reasonable rate in the circumstances.

" Is the coal clause in and of itself a legal rate? Replying to this question, we must bear in mind that coal clauses were generally adopted by electric and some other utilities to meet the unusual conditions which confronted them and the country during the unsettled times incident to the war, when for a period the prices of coal fluctuated rapidly and for a time steadily mounted. These changes in coal prices were at times abrupt. No utility could bring to bear any business sagacity to foretell or estimate for any definite period what these changes would be. Purchases of coal under contract running over long periods of time for delivery could not usually be made. The coal clause rates served during the period mentioned a very useful purpose and probably no other method could have been adopted more equitably designed for the utility companies and the consumers. Under the coal clause tariff the increase and decrease in price of power to consumers followed definitely the increase or decrease in the price of fuel and so, from the standpoint of substantial justice, no injury under them could be done to consumers. With the change to more settled conditions such rates, having served their emergency purpose, have largely and properly disappeared from tariff structures. We are not now constrained to declare them illegal, for ye cannot say they were unjust or unreasonable in the results following from their application. In fact, consumers generally throughout the commonwealth were in full accord with the coal clause method of rate determination. As there appears to be no longer a reason for their retention, they should be superseded by more definite rates carried into the tariff schedule and calculated to produce the required revenue."

Were the filed rates, including the coal clause, just and reasonable? After further discussion in its report

Held:

"We find under the evidence that the rates attacked are just and reasonable and cannot be struck down or reparation awarded. It follows from the foregoing that the complaint must be dismissed."

H. C. Frick vs. Duquesne Light Company, Allegheny County Steam Heating Company (No. 871, C-2942) reported October 5, 1920.

"Prior to 1916, H. C. Frick, the complainant, had erected, in the City of Pittsburgh, two large connecting office and store buildings, known as the Frick Building and Frick Annex. The basements he combined into one room and there installed electric light, power and steam heating equipment at a cost variously estimated at $170,000 and at $213,000.

"In 1915, he had another office building, known as the Union Arcade, under construction. This was completed in 1917, and was connected with the other buildings by a subway or tunnel under an intersecting street. The Union Arcade was so arranged that its own light and power plant could be installed in it, or it could be connected with the plant and equipment in other buildings. The three buildings combined contain between 1,500 and 2,000 offices, by far the largest office buildings in the City of Pittsburgh.

"In 1916, negotiations were begun between complainant and respondents in which it was proposed that complainant abandon his own lighting and heating system and procure, over a period of years, heat, light and power from respondents; that respondents purchase the electric and steam heating equipment, which compainant had installed, and lease from him the basement for general use as an electric substation and steam generating plant.

"On November 15, 1916, four agreements were entered into effectuating these proposals. They were so interrelated and interdependent that they must be treated as one transaction. In them it was provided that for a period of 25 years the respondents were to supply complainant's buildings with heat, light and power at rates which were those prescribed in tariff schedules then on file with this Commission. It further provided for increases or decreases in rates, at the end of each five year period, based upon the price of coal at respondents' Brunot Island plant, and for the termination of the contract by complainant upon notice at the expiration of the tenth, fifteenth or twentieth year. The plant equipment of complainant was purchased for $50,000.00; the lease reserved an annual rental of $10,000. The complainant claimed that the change from his private plant to respondents' system required him to expend $160,000, but the cross-examination of his witness, with respect to this matter leaves us somewhat in doubt as to whether the whole of that amount is attributed to the change from his private system to respondents' service.

"The respondents filed with The Public Service Commission, and duly posted and published to become effective May 31, 1918, a supplemental tariff making material increases in rates, changes in classification of patrons, and in the basis upon which charges to these patrons for electric and heat service would thereafter be imposed. The rate structure of the supplemental electric tariff was somewhat complicated, perhaps not more so than those usually employed by electric companies but rendering it somewhat difficult for other than those technically trained or experienced to allocate to its different schedules the service required by any particular consumer.

"There seemed to be doubt upon the part of respondents as to whether this supplemental tariff affected complainant's rates for, continuing until October, 1918, bills were rendered him for heat, light and power at the rates set forth in the contract. In October a higher rate, for electric service alleged to be that authorized by Schedule "F" of respondents' supplemental tariff of May 31st, was imposed and billed. It ultimately led to the filing of the complaint now before us for disposition.

"The issues raised by complaint, answer and testimony are not complex, although to a certain extent novel. The main propositions are advanced by complaint:

"First: That there is nothing in the Public Service Company Law, or deliverances of the courts with respect to it, prohibiting or invalidating contracts between utility companies and their individual patrons so long as the rates were those prescribed in then filed tariffs, and so long as these rates remain just and reasonable, and are not unjustly discriminatory or unduly or unreasonably preferential: (Art. V, Sec. 3).

Under such circumstances it was maintained, no question of public policy is involved, requiring the exercise of the police power of the state in the public interest, to set such contracts aside.

"Second: That the heat, light and power demands of these buildings, with attendant conditions, justify a separate classification in rate schedules and the maintenance of the rates in effect when the contracts were made.

"It was testified on the part of respondents that the rates for electric service under the new schedule would place complainant under Schedule "F" of the tariff complained against. This schedule provided for a demand charge applicable to all consumers, and for an energy charge divided into three blocks so that as the demand on the system, the maximum demand, increases, the charges in the first and second block decrease with respect to the number of kilowatt hours charged in each block. The schedule recognizes as a principle in rate making, the giving of an advantage in rates both on higher demands and on the greater amount of energy consumed.

"On the basis of consumption and demand under this rate, respondent's witness testified complainant's bill for electric service for the year ending December 1, 1919, was $86,748.83. This witness when asked how this charge compared with other large consumers replied that there are no office buildings that compare in size and demand with the group of Frick Buildings, the load factor for which the witness described as "good". This rate schedule ("F") recognizes time as a factor in its tariff, the same witness testifying "that is a provision (one year) we have in all our contracts."

"Considerable emphasis was laid by complainant upon the advantage obtained by respondents from the lease and rights incident thereto, to use complainant's premises for a sub-station for its general public purposes, under which electric current at 11,000 volts was there transformed and distributed, about 50 per cent going to supply the Frick Buildings and the balance outside, and steam heat was furnished to other buildings."

With respect to classification, the Commission

Held:

"It is unquestionably the law in Pennsylvania, that rates, tariff schedules of which are filed with the Commission, are the only legal rates, at least in so far as utilities and their individual customers are concerned, but it is no doubt equally true, and, in fact, is a matter of almost universal practice, that rates so filed may be the subject of contract. It follows, of course, that these contracts thus entered into must not, at the time of their making, offend against public policy; and it further follows that though just and reasonable when made if they later become unjust or unreasonable or are discriminatory or preferential within the prohibition of the statute, they must be subordinated to the welfare of the general public and, if need be, set aside. A mere reference to respondents' Exhibit 5, presumably containing a list of the consumers must nearly approaching in demand, consumption and general character of the service, coupled with the entire testimony in the case, not necessary here to be adverted to, plainly places the Frick Buildings, as one of the respondents' witnesses stated, in a class by itself both with respect to heat and electricity.

"Time is an important factor in rate classifications. Particularly is this so in electric and steam heat service. Where the consumption is large, the utility company cannot, over night, be expected, without notice in all instances, to be prepared or equipped to supply necessary amounts of current or heat; on the other hand, it is not possible for consumers of that class to quickly install their own private plant if they do not wish to rely upon the public service. The time factor, therefore, is one which leads to a fair measure of stability and certainty in service, equally important to utilities as to their patrons.

"In the instant case, the complainant sold the equipment constituting his own plant; leased for a long period of years the space in his building in which it was installed to respondents; made changes and incurred considerable expense in order to utilize respondents' service. While not a matter developed in the testimony, it was inevitable that respondents were subjected to considerable expense in taking on these service obligations."

With respect to effect of contract;

Held:

"In numerous cases this Commission has given weight in determining the reasonableness of rates under attack to the understandings or contract which individuals and the utility companies serving them reach. In other words, these agreements have been held by the Commission to be some evidence of what is just and reasonable in particular instances. Here the complainant and respondents not only agreed that the filed rates were reasonable and would remain stable for a period of at least five years, but they incurred extraordinary expenses and made important changes upon this assumption which, presumably, they would not have done had the term been shorter or the rates uncertain. This understanding was made when the Public Service Company Law was in effect. It was made on the basis of rates which had been lawfully posted, published and filed. Assuredly no ground of public policy under the evidence before us exists, which requires us to set aside their joint judgment until or unless it be shown that the time element which they have fixed to the legal rate has resulted in or will result in a discriminatory or preferential situation inimical to their other patrons, to the public at large, or that the former rates have become so unjust and unreasonable that respondents on ground of public policy should be relieved therefrom.

"In final analysis there is very little or no regulatory difference whether contracts of this kind shall have a legal status as such to be overthrown only if and when they are found unjust, unreasonable, discriminatory or preferential, as affecting the public generally, or they are given due weight by the Commission as evidence in determining these same factors which are after all the very basis of all properly imposed rates."

And with respect to time factor in classification of rates,

Held:

"The test in each instance is the same. All rates must be just and reasonable and not discriminatory or preferential. Classification in rate schedules, with respect to time, is a just and reasonable factor to be considered, and, as heretofore pointed out, is extensive-

ly employed by nearly all classes of utilities in framing their tariff schedules. Railroads have their monthly and other commutation tickets. The value to the public is in the reduced rates and to the carrier in a greater certainty and regularity of train carriage."

As to the rates themselves,

Held:

"While it is true the technical burden of proof was on the complainant because the tariff became effective May 31, 1918, and the complaint was not filed for many months thereafter, but the failure of the respondents to enforce the increase, together with their agreement as to what was a just and reasonable rate, at least for the period of five years, with the other evidence in the case, leads us to the conclusion that complainant has met whatever legal burden was imposed by law upon him. The rates, in so far as this particular complaint is concerned, in effect prior to May 31, 1918, were and are under the evidence, just and reasonable and no public necessity, either as affecting the respondents, or their other patrons, was shown or claimed, nor is there anything before us by which we could find that the rates in the prior heat or electric schedules, which are the contract ones, if continued, would be discriminatory or preferential as against any other of respondents' customers. On the other hand we are forced to the conclusion that Schedule "F", of the supplemental tariff of May 31, 1918, is, under all the evidence, unjust and unreasonable, as affecting the complainant, and its continuance would be unjustly discriminatory and unduly and unreasonably preferential as against him.

"An order should be issued authorizing the respondents to file on one day's notice a supplement tariff, providing for classifications than those now on file, which would be applicable to services rendered for steam heat and electric light and power in the Frick Buildings mentioned, and to such other patrons as may hereafter fall within these classifications, and these at the rate in effect on November 15, 1916. If at any time hereafter it be established by appropriate proceedings that the rate and schedules here authorized are then unjust or unreasonable or are unjustly discriminatory or unduly or unreasonably preferential, a modification of this authorization will be made.

"Should the respondent fail to file supplemental tariffs as indicated, within 30 days of the service of this report upon them, the Commission will make such further order as may be required."

Apollo Steel Company vs. West Penn Power Company (No. 1016 C-3536) Reported July 11, 1921.

"The only question for determination in this case is whether a certain contract affecting rates is binding and enforceable, made May 24, 1912, between the complainant and respondent, whereby the former was to make an installation for the operation of its plant by electric current to be supplied by the latter. This contract was to continue in force for a period of 10 years and thereafter until either party gave the other six months' notice of a desire to terminate it, and during its existence the complainant was to make exclusive use of respondent's current and pay therefor a certain monthly ready to serve charge and $1.33 per kw. of demand plus one-half cent for current, subject to a discount of 33-1/3 per cent on the energy charge on all bills paid before the fifteenth of the succeeding month or within fifteen days after the date of the bill. The contract was executed in two separate writings, the one embodying the principal agreement, and the other the provision for the discount of 33-1/3 per cent on the energy charge fixed in that agreement. The explanation for making two bites of the cherry is that respondent did not want other prospective power consumers to know that it was making a discount to complainant of 33-1/3 per cent upon the rate for current consumed. Later, the complainant, believing that its power was costing too much, made application to respondent December 1, 1913, for modification of the contract made May 24, 1912, so that an additional discount of 10 per cent would be allowed. This request was acceded to by respondent, and the contract, as thus modified, provided that on and after December 1, 1913, there should be allowed a discount of 33-1/3 per cent and 10 per cent on each monthly bill for energy charge, if the bill were paid before the fifteenth of the succeeding month or within 15 days of the date of the bill.

"The contract evidenced by these three separate writings is the one which the complainant alleges should be enforced in connection with respondent's rate schedule, effective March 1, 1918. No objection is made to this schedule increasing rates, but it is contended that there should be applied to the rates therein provided discounts of 33-1/3 per cent and 10 per cent in favor of the complainant in accordance with its contract for such discounts.

"The contract is sought to be sustained:

"(a) On the ground that complainant was a pioneer user of electricity in the Pittsburgh district and territory tributary thereto for driving the rolls of a sheet steel plant and that in making an expensive installation for the use of electric current for this purpose, the complainant assumed the risk of it proving a failure and the consequent loss that would ensue in changing to an installation for use of steam then in general use in that district; also the loss of business and the expense incurred in maintaining its organized force, etc., incident to the six months' time that would be required in making this change: and

"(b) the advertising value that a successful operation of complainant's plant would be to respondent in securing other like power consumers. It is also contended that in the operation of its plant by electricity it assumed the risk and hazard of interruption in transmitting the current over a 40 mile transmission line, which interruptions, depending upon their length, might prove very costly to complainant and the further fact that it obligated itself to use the respondent's service exclusively for a period of 10 years.

"For the reasons stated, complainant contends that it is entitled to be placed in a class by itself and thereby receive the benefit of these discounts on the filed rate for current used. The advertising value of such electrical installation and operation of its plant is especially stressed by complainant as a supporting consideration of the contract which it now seeks to have enforced.

"It appears from the undisputed evidence that an electrically operated sheet steel plant was installed at Blasedale, New York, and also at Middletown, Ohio, prior to the making of the contract in question. These plants were being operated successfully and were

visited by a representative of complainant before equipping its plant to be so operated."

With respect to risk of interrupted service:

Held:

"The installation of electric drives was not a new or untried venture and there was no serious question about a successful electrical installation in this case. The only hesitancy complainant had in adopting this method of operating its plant was on account of the transmission of the current over a long distance line or from a power plant 40 miles away, having in mind that such line was much more likely to be disturbed and out of repair and the interruptions of service over it more frequent and for a longer period of time than if the power plant were close at hand. It was common knowledge, however, that electricity was being successfully transmitted over much longer distances and aside from the inevitable interruptions in all electric service it was apparent that the additional risk assumed in the use of current over a long distance line depended largely upon whether the line was properly constructed, maintained and operated. In any event, whatever risk of interruption in the service existed on account of the long distance transmission would have to be assumed by subsequent similarly situated users, and if the interruptions proved to be of a more than ordinarily frequent and serious character, the advertising value of complainant's installation and the use of electricity as a demonstrating operation would be nil."

With respect to the advantageous contract:

Held:

"A careful consideration of the testimony and of all the facts and circumstances attending the making and execution of the contract in question lead to but one conclusion, namely, that the consideration which moved the complainant to enter into this contract was the desire and expectation of getting a more convenient and less expensive power than steam for operating its plant. This was gone into very carefully by complainant, and all the elements of cost entering into the operation of its plant by steam were duly considered and the conclusion reached that the use of such power would cost a cent and a small fraction per kw. hour, based on the amount of steam required and the number of hours the plant would operate, and evidently that an electric drive would be more desirable and less expensive than steam, on the basis of the discounted rate agreed upon for electric current. It appears that the term of the contract was fixed at 10 instead of 5 years at the suggestion of the complainant, thereby evidencing a belief on its part that it was getting a favorable power rate for operating its plant. The respondent contends and offered testimony in support of its contention that in the negotiation and execution of the contract in question, no consideration whatever was given to the alleged advertising value of the electrical installation for the operation of its plant; that all the terms and conditions of the contract were agreed upon before there was anything said about the advertising value of the installation, and that this was suggested and referred to in drawing up the supplemental paper emboyding the previously agreed upon provision for a discount of 33-1/3 per cent as a colorable consideration for such discount. The Commission, however, does not deem it important whether the contract had an advertising value or not, or whether this was or was not a moving consideration for the discount claimed."

With respect to abrogated contracts:

Held:

"It appears from the unrefuted testimony that there are a number of sheet steel mills now being operated by electricity in the Pittsburgh district and territory tributary; also that respondent, prior to filing its rates schedule under the Public Service Company Law, had no fixed charge for current furnished these and other large consumers, but made separate contracts with them in which the rate varied in each case as occasion required in securing the business. When it filed, posted and published its tariff and schedule of rates, effective March 1, 1918, as required by law, it treated all these special contracts as thereby abrogated and applied the filed rates alike to all consumers. The complainant, so far as the evidence discloses, is the only consumer who has not acquiesced in this action taken by respondent, or contends that its special contract rates should prevail over the filed rate. This contention is based on the allegation that the circumstances and conditions under which current is being furnished distinguish it from other consumers and entitled it to the rate differential, provided by its special contract with respondent."

Counsel for complainant submitted an exhaustive brief on the question of the character of discrimination which the law condenms, and also on the distinguishing conditions and circumstances which justify a rate differential.

With respect to this:

Held:

"The brief has been read with interest and the cases cited carefully considered, but we are unable to give any of them a controlling application to the facts and circumstances of the case under consideration. It is to be observed that complainant does not furnish any equipment or supplemental facilities in supplying the current used by it. The installation which it made was not a substituted one, or made to displace one for the use of a different kind of power, nor did it result in the scrapping of an installation which complainant had in use for operating its plant. It is receiving its electric power under precisely the same physical conditions and circumstances that other large and like consumers are being supplied, and the only conditions and circumstances attending its use by complainant which distinguish it from these other power users are involved in the fact that it was the first in Pittsburgh district to make use of electric power for operating a sheet steel mill. In the opinion of the Commission, these are not the distinguishing conditions and circumstances within the purview of the law which justify a rate differential. Aside from the alleged advertising value of the complainant's installation and its agreement to make exclusive use of respondent's current for a period of 10 years, the complainant did not obligate itself to do anything whereby the respondent would receive a compensatory return for its service other than the rates which the complainant agreed to pay for the same. Upon a careful consideration of the evidence, we perceive no legally recognized conditions or circumstances affecting the service furnished complainant which differen-

tiate it from that supplied other large and like consumers of electric power in the same district. In other words, it appears from the evidence that the service is the same and is being furnished under substantially the same conditions and circumstances and at the same cost to the respondent."

Regarding discrimination and undue preference:

Held:

"In the opinion of the Commission the risks and hazards which complainant claims to have assumed as a pioneer user of electric power in the Pittsburgh district for operating a sheet steel mill, or the alleged advertising value of such installation, do not constitute the conditions and circumstances referred to in the Public Service Company Law which would warrant an individual classified service with special rates, and as we interpret the law applicable to the evidence in this case, there is nothing to distinguish the service supplied to the complainant from that furnished to other large and like consumers in the same district, and to permit the complainant to receive this service at more than one-third less than its competitors and other like consumers are paying for the same service would be to unjustly discriminate against them, and would be making or giving an undue and unreasonable preference and advantage in favor of complainant and subjecting its competitors and other large consumers of respondent's power in Pittsburgh district to an undue and unreasonable prejudice and disadvantage in violation of the Public Service Company Law.

"For the reasons stated an order will be issued dismissing this complaint."

St. Clair Coal Company, Inc., vs. Eastern Pennsylvania Light, Heat and Power Company. (No. 1041. C-3131-3702) Reported August 15, 1921.

"The complainant, a large coal operator with two collieries known as the St. Clair and Silver Creek operations, respectively, located near the borough of St. Clair in Schuylkill County, Penna., filed a complaint December 10, 1919, at No. 3131, against the respondent's new tariff effective December 12, 1919, and in October, 1920, filed a complaint at No. 3702, against the new tariff of respondent effective November 1, 1920.

"Complainant is one of the largest wholesale power consumers of the respondent.

"The respondent is a public service company supplying electricity for light, heat and power in and about the vicinity of the complainant's mines and elsewhere in Schuylkill and Columbia counties. The territory served is in the anthracite coal mining region of Pennsylvania, comprising about 400 square miles and a population of about 134,000 people.

"The complainant entered into a contract with the respondent for electric service at its Silver Creek Colliery on November 20, 1917, at the time the mine was opened, but complainant did not make a service connection at its Silver Creek Colliery until October 24, 1918, 11 months after the contract was signed, it receiving its first bill on December 5, 1918, for the period from October 24th to December 3rd, 1918.

"Complainant was billed electric service at rates set forth in Schedule "C" of Tariff No. 6 and paid the same without protest up to and including May 1919, although complainant knew they were different from those rates contained in its contract and although this tariff contained a coal clause and extra charge sometimes called a war labor clause. The contracts were entered into during an unsettled period in the public utility business. The abnormal conditions caused by the world war brought about a rise in prices."

After the Public Service Commission's disapproval of the coal and war labor clauses in the Slate Belt vs. Pennsylvania Utilities Case, "respondent filed its Supplement No. 1 to its Tariff No. 6 which did not disturb any of its rates, but Schedule C.1 thereof relating to wholesale power rates, eliminated from the respondent's wholesale power rates the coal clause and extra charge. This schedule was intended to absorb in the body of the rate structure the coal and war clauses of the former tariff and did not materially increase the original cost of energy to the complainant."

"Respondent's Tariff No. 7, effective November 1, 1920, was filed, according to the evidence, because respondent faced increased costs of coal, other material and labor, and because the wholesale power rates under the above mentioned supplement were proving too low. To cover these increased costs Schedule "C" of Tariff No. 7 increased the demand charge for kw. consumption in excess of 74 kw. maximum demand used between the hours of 10 p.m. of one day and 4 p.m. of the next day, in excess of the demand between the hours of 4 p.m. and 10 p.m. any day, and increased the energy charge;" the lowest energy rate being advanced from 1.10c to 1.35c per kw.hr. for all in excess of 300,000 kw.hr. consumed per month, less 1/10 of 1 per cent prompt payment discount. The increase was admitted to amount to 30 per cent of the complainant's class of customers. Respondent estimated that the increased revenue from Tariff No. 7 during one year would be $106,400, and that the operating expenses will be increased in approximately the same amount.

"Up to about 1917, respondent was operating with a residential lighting load and incidental retail power, the bulk of its business being between 4 o'clock p.m. and daylight. Previous to 1918 very little business was done on the wholesale power schedule, but since that time the respondent company has taken on wholesale power customers and now it has 20 customers under Schedule C of its present Tariff No. 7. These customers had been secured at the time the original complaint was filed in this case and all of them are coal mining companies operating mines or washeries. The greatest demand which all of these customers create is between the hours of 7 o'clock in the morning and 3:30 o'clock in the afternoon, and all the mines operate at practically the same time; and the complainant's mines are operated at the same time as other mines in the region, namely, from 7 a.m. to 3:00 p.m. It was shown at the hearings that the plant peak is greatest about 10:30 o'clock a.m., and about 1:30 to 2:00 o'clock p.m.; that all the coal companies taking power under this schedule take their maximum demand at about the same time of day and the variation is very slight. At the time the original contracts were made with the complainant, the respondent did not have the other coal mines as customers and was carrying in the main a lighting load and the maximum demand of the complainant's mines would have come on the system during the off-peak period; but at the present time, due to the fact that

a large number of the mines and other industries of the region have demanded electric service, the peak has changed to the day instead of the night and the load has been more or less equalized throughout the day and night. The coal mining industry is the principal industry in the territory served and practically everything is dependent upon it. The maximum demand of the complainant and other coal mines does not now come on at the off-peak period, hence the reason and justification is understood for the elimination from Schedule C of Tariff No. 7 of the one and off-peak hour feature of the demand charge in Schedule C-1 of Supplement No. 1 to Tariff No. 6."

As to discrimination:

Held:

"Complainant asserts that the rates in the schedule complained of are unreasonable, discriminatory and unlawful as applied to it, because they are higher than those set forth in its contracts. It is admitted that in determining the reasonableness of the respondent's rates, the Commission is not bound by the terms of the complainant's contracts, but there is an equally well substantiated principle, complainant asserts, that a special burden of proof rests on the respondent company in this case to show the need of breaking an agreement and complainant argues this the respondent has wholly failed to do.

"The evidence shows that the rates in Schedule "C" 1 of Supplement No. 1 to Tariff No. 6 were just and reasonable and not discriminatory during the period the supplement was effective, and that the present wholesale power rates under Schedule "C" of Tariff No. 7 are just and reasonable and not discriminatory.

"The respondent introduced evidence which showed conclusively that the rate which it is charging the complainant is lower than the rates for similar service charged by other electric companies operating in the same or adjacent territories under substantially the same conditions."

The complaint was not against the rates under any other schedule than that applying to wholesale power voltage. Respondent showed that after allowing 3 per cent depreciation on depreciable property for 1920, its net income was 4.9 per cent on $4,000,000, the valuation testified to, and for 1919, 3.8 per cent upon the same valuation.

The Commission in this case was not asked to find a valuation of the property and to fix an annual rate of return on that valuation; it was asked by complainant to find that respondent has failed to meet the burden of proof upon it, either to justify the reasonableness of the rates complained of or the property of alteration of the rates to which it agreed.

Held:

"In view of all the circumstances, testimony and record in the case and after due consideration of the same, the Commission finds and determines that respondent has proved that its wholesale power rates are not unreasonable and not unjustly discriminatory and that, therefore, the complaint should be dismissed."

Rules and Regulations.

A. M. Gates, et. al. vs. Coalport Light, Heat & Power Company (No. 405. C-1698) Reported May 7, 1918.

"Upon the complaint of Lang, et. al., vs. Coalport Light, Heat and Power Company, a public service company supplying electric lights in the Borough of Coalport (C-1211), the Commission directed on May 8th, 1917, the respondent to furnish "a twenty-four hour service throughout its territory" and to place consumers upon a measured or metered basis.

"The pending complaint avers that the respondent has not fully complied with this order, particularizing that it does not furnish Sunday service during the daylight hours, and that it has not installed meters for all its patrons.

"Other averments in the complaint were not pressed, except the following: Respondent's Rule 8 which provides: "nor shall it be liable in any event for damages to persons or property arising, accruing or resulting from the use of the current for either light or power;" respondent's Rule 10 requiring customers to deposit $5.00 as security for future payments on which four per cent interest is allowed by the company. These rules were filed subsequently to the order of the Commission (C-1211) and are objected to as unreasonable. As a substitute for them, the complainant urges that a lower amount of deposit be fixed and that the rule be limited in its application to those who are not financially responsible, and it is urged that a rule allowing a discount of five per cent be ordered for prompt payment of bills.

"The respondent is a comparatively small electric light company with not more than 250 patrons, none of whom are large power consumers. According to a completed list, for the month of August, 1917, but two of that number paid more than $10.00 for their monthly service and neither of these as much as $20. Not more than 10 paid upwards of $5, while 155 were not above $1.50. According to the evidence, the demand for Sunday service is limited to the occasional office use by two dentists, one of whom never used it on that day except in emergency cases; a gasoline street service; a few cellar lights and several churches. The churches, however, do not require the current except for lighting at evening hours. The respondent's equipment consists of a single unit with no reserve provisions. The rates which the company charges are not high, measured by the rates charged by other companies."

With respect to Sunday daylight service:

Held:

"It is obvious that the maintenance of service during the daylight hours on Sundays would require an expenditure for fuel and labor quite out of proportion to the return or to the public demand, and in fact might require the installation of a reserve unit in order to permit the respondent to attend to the plant overhauling and repairs which are now attended to on Sundays. The Commission must take into consideration not only the convenience of the few who desire Sunday daylight service, but must view the matter from the standpoint of the patrons who do not wish or need this service. The increased expense of the Sunday daylight service would be reflected in the rates charged all these patrons, and to order it at a time when the nation is seeking to conserve its supply of coal and labor would under the present conditions be as unwise as it would be unpatriotic. The respondent is supplying current on Sunday during the hours when light is required and it should continue

to do so, and it will be required in addition to render 24 hour a day service on all other days."

With respect to liability relief:

Held:

"Respondent's Rule 8, by which it proposes to relieve itself of liability for damages to persons or property arising or resulting from the use of current for either light or power, has no place among the filed rules. While it may be admitted that such a rule could not in any wise change the existing law, or shift the legal liability of respondent, and therefore it might be ignored as innocuous, still its presence might lead to confusion or misunderstanding. It should therefore be eliminated, and the Commission will so direct."

With respect to deposits and discrimination:

Held:

"As to Rule 10, by which the respondent requires all patrons to deposit $5.00 with the company to secure future payments, it may be suggested that the time and manner of its enforcement were unfortunate and in part illegal. The rule was promulgated shortly after the order of the Commission requiring meters to be installed. The installation of meters by the company was predicated in part upon the payment or promise of payment of the required deposit. It was not exacted from those who continued on flat rates. The original complainants (C-1211) were singled out by the respondent for the application and enforcement of the deposit rule. Some seven of them were cut off for refusal to pay, while others were permitted to have service without payment, or upon their promise of payment. In some instances officers of the company gave or guaranteed the deposit for patrons, and in others, stockholders who were patrons, were continued on a flat basis without meter installation or without making the required deposit. The rule has been discriminately applied, and applied in such a way as to indicate an intention on the part of the company to select those who have appealed to this Commission for relief as the ones against whom the rule would be rigorously imposed. Such a policy on the part of any utility company cannot but result in an aroused public sentiment against it, and is in violation of a fundamental basis for public utility success which is that public confidence and favor are important assets. Of course, the discriminatory practices under this rule must cease."

In explanation of the law, the Commission said:

"We now turn to the rules itself. The Public Service Company Law gives a rather wide range of discretion to utility companies. They may establish reasonable rules and regulations, subject to existing law, governing the conduct of their business and the conditions under which they shall be required to render service. In Article III Section 1, Paragraph C, their authority is specifically set forth: They 'may require the payment of charges in advance, the making of reasonable minimum payments and deposits to secure future payments of such charges, or' they 'may allow discount for prompt payments of the same, or impose penalties for failure to pay promptly'. It will be observed that a wide latitude under the law is allowed utility companies in the formulation of their rules. A rule requiring deposits to secure future payments comes within the right of the utility. They are not compelled to make such rules, but on the other hand they have the right so to do, and there is nothing in the Act giving them this right which compels them to distinguish between patrons who are financially responsible and those who are not. In this connection, however, it may be well to point out that the Public Service Commission has never held that a utility company may not make a rule with respect to deposits distinguishing between those who are financially responsible and those who are not. In fact, many of the utility companies of the state have such a differentiating deposit rule."

With regard to the amount of the deposit:

Held:

"That the $5.00 deposit is unreasonable, and that $3.00 is a reasonable one under the circumstances. Should it appear, however, at a later period that the changes incident to the meter installation would make this insufficient, leave will be granted respondent to apply for a modification of the order fixing the amount."

Regarding rate of interest on deposits:

Held:

"There appears no uniformity of practice among the utilities with regard to the rate of interest allowed on deposits. The range is from three to six per cent. Passing by the question whether the interest rate was properly before the Commission in this proceeding, we are not now inclined presently to interfere with it in this case, reserving the question for final adjustment if and when we issue a general order affecting the same.

"The Public Service Company Law above quoted permits utilities to promulgate rules offering discount for prompt payments, but the law does not require them so to do. The Commission is therefore without power to interfere with respondent's discretion in that respect, and this feature of the complaint cannot be sustained."

Demand, Minimum or Service Charge.

Borough of Auburn, et. al. vs. Eastern Pennsylvania Light, Heat and Power Company (No. 917 C-3109) Reported December 21, 1920.

"This complaint is brought by the boroughs, townships and villages of Auburn, Ashland, Locust Dale, Minersville, Frackville, Tamaqua, Ringtown and Girardville, and Grant Kyler a resident of Auburn, charging that the flat-rate service charge of 50 cents per customer per month, as contained in Schedules "A" General Service and "B" Retail Power of the respondent's tariff P. S. C.-Pa. No. 6, effective November 1, 1918, is unreasonable and unlawful."

"Testimony was introduced to show that the earnings of the respondent under the rates in effect are not excessive. In fact complainants' counsel filed of record a statement withdrawing the complaint 'in so far as it is directed against excessive returns to the respondent company.' The issue then remaining is whether the service charge is inequitable or discriminatory as between the several classifications of consumers.

"The respondent has in effect simultaneously a minimum charge and a service charge, otherwise known as a ready-to-serve charge. The former is $1.00 and the latter 50 cents, both per customer per

month. The stipulation quoted outlines how these charges are applied. The effect of the application is that under Schedule "A" the consumers of one, two, three and four kwh. pay respectively a service charge of 88 cents, 76 cents, and 52 cents.

"Schedule 'A' in addition to the flat-rate service charge of 50 cents per customer per month contains a minimum charge clause as follows:

> "A minimum charge of one dollar ($1.00) per month shall be made for each service meter. An additional minimum charge of one dollar ($1.00) per month shall be charged for each hp. capacity in motors connected in excess of one hp."

"Schedule 'B' also contains the service charge as well as a minimum charge based upon the connected hp., and provides that in no case shall the minimum charge be less than one dollar per month.

"The service charge in its widest scope embraces the consumer's costs and a capacity charge. The minimum charge includes both and a charge for energy. The minimum charge based upon the connected hp. includes the three factors and in addition recognizes, in a measure at least, the extraordinary requirements of the individual consumer, usually covered by a so-called demand charge. It is apparent, therefore, that the respondent by including in one schedule all these charges, i.e., service charge, minimum charge, and minimum charge based upon demand, is repeating the several items which constitute those charges.

"In Fox, et. al. vs. Pine Grove Electric Light, Heat & Power Company, 8 P.C.R. 336, concerning duplication of service costs, we held:

"With respect to the service charge against which complainant's protest it may be said that a stand-by or ready-to-serve charge is not an unusual thing in tariff schedules. Different state commissions have approved such a preliminary charge as a legitimate source of income in the business of a public utility. In town council of Lewistown vs. Penn Central L. & P. Co., 7 P.C.R., 97, this commission allowed a ready--to-serve charge of 75c per month under the state of facts presented in that case. However when such a charge is imposed it cannot be arrived at arbitrarily or at random, but must be supported by proper and sufficient data to show what it costs the utility to hold itself in readiness to furnish service on demand.

"In this instance there are no figures produced to indicate how much it has cost respondent to meet the demand for service, or why 50c per month or any other amount should be collected as a service charge from the consumer. As there is also a minimum charge of one dollar per month carried in respondent's tariff, and as the minimum charge is made up in part of the items which enter into the cost of installing service, the commission will not allow respondent under existing circumstances to collect a separate charge for service at the same time. Accordingly the service charge should be stricken off the tariff of the respondent company in every one of its schedules. The conclusion here reached is further strengthened by the rather significant fact that out of a total of 185 patrons, 100 of them belong in the class of minimum consumers."

"Upon the facts of record we are constrained to find that in this particular case the joint application of the service charge and the minimum charge is inequitable and unjust to the consumer who is called upon to pay both. The schedule under attack is so designed that items included in the minimum charge are also covered by the service charge and is therefore unjust and unreasonable to that extent. The respondent is directed, therefore, to revise its rate schedules within 30 days, and upon statutory notice, so as to eliminate the discriminatory and inequitable duplications resulting from the joint application of minimum and service charges."

Valuation.

Complaints against the Philadelphia Suburban Gas & Electric Company (No. 911. C.-1794 et al.) Reported December 21, 1920.

"In the complaints of the Boroughs of Phoenixville, Royersford, Spring City, et al. against the Philadelphia Suburban Gas and Electric Company, the Commission directed the respondent, inter alia, to prepare and submit an appraisal of the gas property serving these communities. Complaints are now pending before the Commission directed against increased rates for gas service in the respondent's Phoenixville, Jenkintown, Coatesville, and Delaware County districts and against rates for electrical service in Jenkintown and in the Pottstown-Phoenixville-West Chester district. Rates for steam heating service in West Chester are also before the Commission. In a number of these cases, hearings have been held and have progressed to such a point that the Commission is convinced that a satisfactory adjudication of the pending cases will require the determination of the value of respondent's property in the various districts concerned. In view of the many parties involved, the Commission will issue an order directing the respondent to prepare and submit an appraisal of its property in conformity with the following general directions and specifications as to the data to be submitted. If it develops during the progress of the work that certain of these requirements cannot be met or that modifications seem necessary, the Commission will pass upon such matters as the individual circumstances seem to warrant. The respondent will be directed to complete the work of inventory by July 1, 1921, the work of appraisal by October 1, 1921, and to submit to the Commission monthly reports as to the status of the work.

General Directions.

"An inventory and appraisal of each of the properties is to be prepared by the respondent, one copy to be offered as an exhibit one copy to be filed with the Bureau of Engineering, and one copy furnished to the complainants. Authorized representatives of the complainants are to have reasonable access to the property and inventory as the work progresses and similarly with respect to the appraisal and the accounts and records. The work of inventory and appraisal and any studies or check the complainants desire to make is to proceed simultaneously to the fullest extent possible and thus avoid delay due to step by step procedure. The complainants should therefore determine at an early date and not after respondent's work is all completed, to what extent they desire to check and investigate and arrange for the prompt prosecution of such work. The inventory and appraisal work is to be thorough, but to proceed along lines and by methods that will yield reasonably accurate results and avoid the costs and delay incident to unnecessary detail and refinements. Much time

and cost can be saved by proper grouping of items and by determination of typical combinations.

"The inventories and appraisals should follow the uniform classification of accounts as far as practicable and should where necessary, recognize geographical or municipal boundaries and the possible need of segregation. In short, the purpose of the appraisal, to furnish a basis for determining rates, should always be kept in mind.

Inventory.

"The respondent is to prepare a complete inventory of the used and useful property as of March 31, 1921, for each of its divisions and sub-divisions.

"Additions and retirements from plant subsequent to this date and up to the date of final hearing are to be submitted by respondent at that time. The inventory shall show the age of the various items of property and data relevant to the determination of present condition and estimated life.

Appraisal.

"The respondent shall determine for each of the divisions and subdivisions of its property:

(1) "The original cost as shown by the books and records as of March 31, 1921. Where the records are incomplete or where a purchase price forms the opening entry, estimates of the property then acquired and its probable cost of construction are to be prepared from such records as are available.

(2) "The historical cost as shown by the application to the items of inventory of unit prices that were current and under the conditions that existed at the time of installation, reasonable prices actually paid to govern where ascertainable.

(3) "A reproduction estimate, giving cost new and cost new less accrued depreciation, on the basis of fair average prices for material, property and labor prevailing during the ten (10) year period ending December 31, 1920.

(4) "A similar reproduction estimate based on fair average prices prevailing during the year ending March 31, 1921.

"The above specifications are not intended to restrict the parties in interest in the presentation of their case, and they may offer appraisals on other bases if they so desire."

Miscellaneous.

Borough of Mt. Carmel vs. Edison Electric Illuminating Company (No. 389. C-1918) Reported April 8, 1918.

As to illegal notice of change of rate:

"The Borough of Mount Carmel complained against the rates of the Edison Electric Illuminating Company which are contained in a new tariff, effective March 1, 1918, and alleged that the notice of the change of rates was not given in accordance with the provisions of the Public Service Company Law.

"There is no doubt that the notice of the change in rates does not comply strictly with the requirements of the Act, but the company published in the daily papers of Mount Carmel and Kulpmont notices that owing to increased costs, it would be necessary for it to change its rates. As a result of this notice the complainants made inquiry at the office of the company and were informed that the rates were to be increased and a new system of charges adopted, and acting upon this information, the complaint was filed in this case prior to the effective data of the tariff.

Held:

"The burden of proving the reasonableness of the increased rate is, therefore, placed upon the company and the purpose of the requirement of the law relating to notice has, therefore, been accomplished. Under such circumstances, the Commission sees no reason for striking down the filed tariff, and an order will be made directing that the case be set down for hearing.

"The complainants also requested the Commission to direct the company to issue certificates evidencing the payments in excess of the prior established rates.

Held:

"The Commission sees no reason why such an order should be made in this case as the receipted bills of the consumers will answer the same purpose as the certificates, and in case the increased rates are determined to be unreasonable, these receipted bills will enable the consumers to prove the amounts paid by them."

H. G. Hood and W. B. Ritchie vs. West Penn Power Company. (No. 478. C.-1730) Reported December 4, 1917.

When change is made in any tariff or schedule, notices shall be posted which plainly state the exact changes proposed.

"On August 4, 1917, the West Penn Power Company, engaged in business in the borough of Washington, Washington County, filed with the Commission an amendment of supplement to its tariff or schedule of rates to become effective September 4, 1917. On October 9, 1917, H. G. Hood and W. B. Ritchie, residents of Washington and patrons of the power company, filed with the Commission a complaint alleging that the new schedule called for an increase in rates that was unjust, unreasonable, excessive and illegal. At the hearing, and prior to the taking of the testimony, the complainant contended that the burden of proof of showing that the new rates were just and reasonable should be assumed by the respondent inasmuch as it had not filed, posted and published its proposed change of rates according to law. The respondent answered that it had complied with the law, and alleges that inasmuch as the complaint was made subsequent to the effective date of the new schedule, the burden of proof was placed upon the complainant. The parties agreed that evidence should be submitted giving in detail the procedure adopted by the respondent in filing, posting and publishing its proposed change of rates and from such testimony the Commission should determine upon whom should be placed the burden of proof. The evidence submitted discloses the following facts: The office of the West Penn Power Company is located in the borough of Washington, Washington County. At this office there is maintained a pay clerk's window where the bills of the patrons are paid and receipted. On the outside of this window and in the waiting room is posted the following notice: "Rates and tariffs of this company are on file and can be inspected by any person without assigning any reason therefore." On the inside of the window and in the private part of the office are hung the tariffs. This condition has ex-

isted for a number of years without change. On August 4, 1917, the respondent filed with the Commission a supplement to its schedule of rates to become effective September 5, 1917. Simultaneously with the filing of the supplement, the respondent company hung a copy of the same with its other tariffs in the private part of its office, but did not post any notice in any part of its office calling the attention of its patrons to the fact that it proposed to change its rates on September 4. There was nothing in the office save the old notice and no notices were posted in any other place. On the 11th day of September, 1917, and after the effective date of the new rates, the respondent caused a notice to be published in the local papers to the effect that a change had been made in its rates.

Held:

"Article II, Section 1 (f) of the Public Service Company Law requires that when a change is made in any tariff or schedule of rates a notice shall be posted which shall plainly state the exact changes proposed to be made in the tariff or schedules then in force, and whether an increase or decrease, and the time when the proposed changes will go into effect. The Commission finds that no notice of any kind was posted as required by said act and that the Public Service Company Law has not been complied with. Wherefore the new schedule of rates is not a legal tariff and consequently must be stricken off and the old tariff restored. An order will be made accordingly."

Conclusions.

There follows a quite general classification of decisions of the Public Service Commission having to do with rates of electric light and power companies, which is offered to assist the student of the subject.

Contracts.

(1) No. 157. C.-495 Borough of Tamaqua vs. Eastern Pennsylvania Light, Heat and Power Company. Reported February 16, 1916.

(2) No. 186. C.-456 F. B. Black vs. Garett Electric Light, Heat and Power Company. Reported June 29, 1916.

(3) No. 287. M. C. 461 In re: Approval of contracts between the Schuylkill Electric Company and the Borough of Girardville. Reported June 5, 1917.

(4) No. 312. C. 1251 North Abington Water Company vs. Abington Electric Company. Reported August 15, 1917.

(5) No. 373. M. C. 778 et al. In re: Approval of contracts between various municipalities in Crawford and Erie Counties and the Northwestern Electric Service Company. Reported February 19, 1918.

(6) No. 472. C. 1810 Fleetwood & Kutztown Electric Light, Heat and Power Company vs. Metropolitan-Edison Company. Reported October 22, 1918.

(7) No. 475. M. C. 937. In re: Approval of five year contract between the Mercer County Light, Heat & Power Company and the Borough of Jamestown, for street lighting. Reported October 28, 1918.

(8) No. 524. C. 2542. Johnson Bronze Company vs. New Castle Electric Company. Reported February 4, 1919.

(10) No. 538. C. 2052. William A. Allen, et. al. vs. Boyertown Electric Company. Reported February 25, 1919.

(11) No. 581. C. 2246. Borough of Beaver vs. Beaver County Light Company. Reported May 13, 1919.

(12) No. 716. C. 1940, et al. Boroughs of Edinboro, Middleboro and Cambridge Springs vs. Northwestern Electric Service Company of Pennsylvania. Reported January 12, 1920.

(13) No. 907. C. 2256. Genzemer and Salem vs. Pine Grove Electric Light, Heat and Power Company. Reported December 7, 1920.

(14) No. 1126. C. 4060. American Phosphorus Company vs. York Haven Water and Power Company. Reported March 7, 1922.

(15) No. 1218. C. 3709. Borough of Middletown vs. York Haven Water and Power Company and York Haven Electric Transmission Company. Reported October 10, 1922.

Contracts and Tariffs Affecting Classification of Service and Rates.

(1) No. 29. C. 141. James Thompson & M. A. Hanna & Company vs. Erie County Electric Company. Reported August 18, 1914.

(2) No. 30. C. 246. Edward J. Meter vs. Metropolitan Electric Company. Reported September 1, 1914.

(3) No. 99. C. 366. J. S. Elliott, et al. vs. Big Spring Electric Company. Reported May 20, 1915.

(4) No. 328. C. 1515. J. T. & A. Hamilton Company vs. Butler Light, Heat & Motor Company. Reported October 23, 1917.

(5) No. 481. C. 2001. Empire Lime Kilns vs. State-Center Electric Company. Reported November 20, 1918.

(6) No. 625. C. 2311. State Belt Electric Street Railway Company vs. The Pennsylvania Utilities Company. Reported August 12, 1919.

(7) No. 662. C. 1717, et al. West Chester Board of Trade vs. Philadelphia Suburban Gas & Electric Company. Reported October 14, 1919.

(8) No. 764. C. 3128. Borough of Tyrone vs. The Home Electric Light & Steam Heating Company (Altoona & Logan Valley Railway Company, Lessee). Reported March 23, 1920.

(9) No. 836. C. 2772. United States Shipping Board Emergency Fleet Corporation vs. Delaware County Electric Company. Reported July 26, 1920.

(10) No. 871. C. 2942. H. C. Frick vs. Duquesne Light Company and Allegheny County Steam Heating Company. Reported October 5, 1920.

(11) No. 888. C. 2255, et al. Fox & Moore, Gensemer & Salem and Pine Grove Borough vs. Pine Grove Electric Light, Heat & Power Company. Reported November 4, 1920.

(12) No. 918. C. 2249. The Jefferson Coal Company vs. The DuBois Electric Company. Reported December 14, 1920.

(13) No. 1016. C. 3536. Apollo Steel Company vs. West Penn Power Company. Reported July 11, 1921.

(14) No. 1041. C. 3131, et al. St. Clair Coal Company, Inc. vs. Eastern Pennsylvania Light, Heat & Power Company. Reported August 15, 1921.

Rules & Regulations Demand Minimum or Service Charges.

(1) No. 31. C. 237. Joseph Cauffiel, et al. vs. Citi-

zens Light, Heat & Power Company of Johnstown. Reported October 6, 1914.

(2) No. 266. C. 423. George E. Stevenson vs. Abington Electric Company. Reported March 6, 1917.

(3) No. 331. C. 1169. Phoenixville, Valley Forge & Strafford Electric Railway Company vs. Philadelphia Suburban Gas & Electric Company. Reported October 23, 1917.

(4) No. 405. C. 1698. A. M. Gates, et al. vs. Coalport Light, Heat & Power Company. Reported May 7, 1918.

(5) No. 488. C. 1441. Light Committee of Council of Lewistown Borough vs. Penn Central Light & Power Company. Reported November 20, 1918.

(6) No. 621. C. 1169, et al. Phoenixville, Valley Forge & Strafford Electric Railway Company vs. Philadelphia Suburban Gas & Electric Company. Reported July 14, 1919.

(7) No. 626. C. 2248, et al. Boroughs of Lansford, Coaldale and Summit Hill and Michael Hartneady vs. Panther Valley Electric Company. Reported August 12, 1919.

(8) No. 696. C. 2255, et al. Fox & Moore, Gensemer & Salen and Pine Grove Borough vs. Pine Grove Electric Light, Heat & Power Company. Reported December 16, 1919.

(9) No. 917. C. 3109. Borough of Auburn, et al. vs. Eastern Pennsylvania Light, Heat and Power Company. Reported December 21, 1920.

(10) No. 1139. C. 4695, et al. Henry M. Hershey, et al. vs. Farmers Electric Company. Reported March 27, 1922.

Valuation.

(1) No. 649. C. 1803 et al. Rose & Myers vs. Mercersburg, Lehmasters & Markes Electric Company. Reported September 15, 1919.

(2) No. 911. C. 1994, et al. Complaints against the Philadelphia Suburban Gas & Electric Company involving increased rates for gas, electric and steam heating service. Reported December 21, 1920.

(3) No. 1063. C. 1826, et al. Borough of Wyoming, et al. vs. Luzerne County Gas & Electric Company. Reported October 11, 1921.

(4) No. 1073. C. 2442, et al. Borough of Meyersdale, Meyersdale Borough School District and Charles A. Phillips, et al. vs. Meyersdale Electric Light, Heat & Power Company. Reported May 12, 1922.

(5) No. 1074. C. 3953. Borough of Albion vs. United Lighting Company. Reported November 15, 1921.

(6) No. 1185. C. 4536. W. T. Spangler, et al. vs. Big Spring Electric Company. Reported July 11, 1922.

(7) No. 1292. C. 1826, et al. Borough of Wyoming, et al. vs. Luzerne County Gas & Electric Company. Reported March 27, 1923.

(8) No. 1352. C. 3948, et al. Borough of Tamaqua and Pennsylvania League of Women Voters of Tamaqua vs. Eastern Pennsylvania Light, & Power Company. Reported September 14, 1923.

Miscellaneous.

(1) No. 35. C. 276. The Good Shepherd Home vs. Lehigh Valley Light & Power Company. Reported October 6, 1914.

(2) No. 40. C. 174. Borough of Lewistown vs. Penn Central Light & Power Company. Reported November 6, 1914.

(3) No. 171. C. 256. M. L. Cooke, et al. vs. Philadelphia Electric Company. Reported April 19, 1916.

(4) No. 372. A. 1716, et at. In re: Application of the Philadelphia Electric Company, Bala & Marion Electric Company and the Delaware County Electric Company for the approval of supplements to the tariffs of said companies. Reported February 5, 1918.

(5) No. 389. C. 1918. Borough of Mount Carmel vs. Edison Electric Illuminating Company. Reported April 8, 1918.

(6) No. 403, C. 1972. Muncy Borough vs. Montgomery & Muncy Electric Light, Heat & Power Company. Reported April 30, 1918.

(7) No. 478. C. 1730. Hood & Ritchie vs. West Penn Power Company. Reported December 4, 1917.

(8) No. 565. C. 2399, et al. Swartz, et al. and Reynoldsville Chamber of Commerce vs. Jefferson Electric Company. Reported April 15, 1919.

(9) No. 596. C. 1570, et al. City of Pittsburgh vs. Duquesne Light Company, Philadelphia Company and Monongahela Light & Power Company. Reported June 2, 1919.

(10) No. 642. C. 2641. Pennsylvania Glass Sand Company vs. The Penn Central Light & Power Company. Reported September 9, 1919.

(11) No. 715. C. 2255, et al. Fox & Moore, Gensemer & Salem and Pine Grove Borough vs. Pine Grove Electric Light, Heat & Power Company. Reported January 20, 1920.

(12) No. 891. C. 3089. Driscoll-Rees Steel Company vs. Hamburg Gas & Electric Company. Reported November 9, 1920.

(13) No. 896. C. 3380. In re: Application of the Pine Grove Electric Light, Heat & Power Company for the approval of a supplement to its tariff P. S. C. Pa. No. 4, increasing rates heretofore determined by the Commission in C. 2255, 2256 and 2259. Reported November 16, 1920.

(14) No. 987. C. 4010. Sun Shipbuilding Company, Aberfoyle Manufacturing Company, Merchants Shipbuilding Company, Egan-Rogers Steel & Iron Company, Scott Paper Company and Allison Steel Product Company vs. Delaware County Electric Company. Reported May 24, 1921.

(15) No. 1060. C 4641. The Public Service Commission of the Commonwealth of Pennsylvania vs. Metropolitan-Edison Company. Reported January 16, 1922.

(16) No. 1390. C. 4691, et al. Borough of Topton, J. L. Trexler, et al. vs. Topton Electric Light & Power Company. Reported January 8, 1924.

DISCUSSION

E. Friedlaender*: There is one question I would like to ask the Doctor, that is, whether the maximum demand rate is justifiable in case of a complete shut down of the plant, as we occasionally get in this country during slack time, and whether this rate should continue at the same value while the plant is shut down.

*Electrical Superintendent, Carnegie Steel Company, Braddock, Pa.

D. M. Petty†: Mr. Chairman, there is one thing I would like to call attention to, particularly to those of us who are interested in buying power; and possibly this may be one reason why the representatives of the Public Service Companies seem to be rather silent. I noticed in most of the cases that Doctor Snow cited that the complaints were considered as not justified, and the attitude of the Public Service Company was upheld.

S. P. West‡: There is one question I would like to ask. I wonder if there has been any plan by the Giant Power Survey Commission to print the map in usable form and send it among the engineering societies of Pennsylvania for their observation and comment? Being a buyer of power we do not like to see all complaints dismissed. But at the same time we feel that the Public Service Commission has done the best it could, and undoubtedly its findings have been correct. It all goes to show that sometimes we do not know what the power which we buy, or even that which we make, is worth when reduced to net income on the capital invested.

In reference to the Giant Power Survey, which was of particular interest to me as I have given this particular subject some study, it happens that the Bethlehem Steel Company Plant at Bethlehem stands in just the relation that the Giant Power Survey anticipates, to the power company with whom we are doing business, and that is we do sell some bit of power over the shut-down periods of the steel plant. Usually on Saturday nights and during the Sunday period. I feel that this is a phase of the development of the relations between the steel industry, particularly those plants having blast furnaces, and the Public Service Companies that should be developed more fully. There are one or two things that I think can be brought out at this time that would be a little startling to anyone unless they have studied the situation. I think the value of a kwh., represented in the week time when the mill is running and at which time you are buying power from the power company, we will say is somewhere in the neighborhood of .0125 to .0150, depending on the load factor and the volume of business. On the other hand when the power company load is light, which happens also to be on Sunday, at which time the steel companies are in a position to sell power, the value of the kwh. is naturally reduced because the power company itself can only save the cost of the fuel that it burns plus a small amount of labor. Its capital charges go on just the same; on the other hand, of course, the capital charges of the steel plant go on just the same. It seems to me that this is one particular point where the Public Service Companies and the other industrial companies who would have surplus power which is derived from waste products either in the form of waste heat or in the form of waste gases, should get a little closer together. I am also a firm believer in the thought that power in the steel industry as a whole should be generated in the plant wherever waste products or waste heat can be utilized. But on the other hand I do not believe that it pays to carry heavy investments in the form of a stand-by plant. I feel that it is better to make a connection with the Public Service Company for stand-by power. I feel that it is very much the same thing as two entering into an agreement to help each other out if they can. I feel that possibly some changes should be made in the present practices of Public Service Companies rendering that kind of service to a steel plant, or any other large industrial plant, and likewise the service which a large industrial plant having a large sized power station can at times render to the Public Service Company to which it may be connected. From my own personal observation there have been quite a large number of times when we have helped our power company, our connection being 8500 kw. capacity. We have helped them out at times when their other customers on our end of the system would have been without power if it had not been for the connection that they had with us. I feel that this is a point that should be given careful consideration.

As an illustration of the value of the kwh. depending upon the time of the week in which it is developed—the figures which I will use will be approximate—there was a month in 1922 I think in which we delivered to our power company approximately 15 per cent more kwhs. in a given month than we took from them, and yet when we settled the bill I think that we paid them something like $15,000 for having the privilege of supplying them with a large amount of power. Of course that is a thing which is only true in a very general way, and at a particular time when we had surplus power; and if the power company would not have wanted the power we, of course, would have had to waste that gas. But I believe that for the economic production of power as a whole that the Giant Power System is a thing that must come. I don't think that the vision of the Giant Power Survey can possibly be too great. I am inclined to believe that there is hardly any man living today who can forsee what will happen 20 years from now. I think that it is well to point out at this time something which came to me with a great deal of force only a few weeks ago. A man in talking about the electrical industry as a whole cited the fact that we are now living in what might be termed "The Electrical Age" and yet a large number of the men who started the electrical industry are still living. I don't believe that this is true of any other industry that has come up in the past, and unless developments are very fast in a few industries about which we know nothing, I don't believe that it will ever be repeated. Take for instance in the case of Edison, who was one of the first pioneers, who considered in one of his earliest experiments that one or two kw. was a large volume of electrical energy, and yet he is living today when we speak of 500,000 kw. plants. I feel that the State of Pennsylvania has taken the lead in establishing a survey such as the Giant Power Survey, and I feel that all of us in the steel industry should lend whatever assistance we can to that organization; and I hope that they will feel free to call upon us as an association at any time if they think that we can be of assistance to them.

M. E. Skinner*: Mr. Chairman, there are of course many interesting phases to the question of central station rates, and particularly as they apply to the steel industry. There are two outstanding factors that were touched upon in Doctor Snow's presentation tonight. I think they are the two factors which

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have caused more discussion than any other two that enter into a central station rate structure. The demand charge of course is one which is of vital interest. Mr. Friedlander touched on that, and I would be interested to know if Doctor Snow could cite any cases which would throw any light on what is a proper demand charge.

I think that an analysis of most all demand charges, or ready-to-serve charges of the central station companies will show that the amount of that charge is insufficient to actually carry the investment which is set aside to serve the particular customer. In other words the Public Service Company usually takes account of the diversity factor among its customers. And I think that practically every rate that I have ever studied in case of a complete shut down was insufficient to carry the fixed charges on the investment from the demand charges of the contracts then in force. I would be very much interested personally if Doctor Snow could throw any light on that question of what is a proper demand charge.

Another very interesting feature of central station rates is the question of coal clause which was touched upon. As the power end of the central station business has developed it has been possible to develop power more and more economically to reduce the cost per kwh. to figures which a few years ago were practically unheard of. And in the sale of that power the development of socalled "off peak" business is a very interesting phase of the central station business. All of you who operate plants are familiar with the economies which can be obtained when the load factor on a plant is built up. It applies in the steel business in the mill operations as well as to the generation of electric power. It seems to me that as we come down in the rates for power we will sometime reach a point at which it will be necessary to take account of the coal varient because of the small margin remaining between the cost of power and the actual price at which it is sold, the tremendous volume of business being relied upon for the profit which accrues to the central station company. Under these circumstances the cost of coal is a very vital factor, and the change which may take place in the cost of coal over a period of a comparatively short time will completely wipe out the margin between the actual cost of production of power and the price at which it is being sold.

I think that both of the papers which were read this evening are particularly interesting to engineers in Pennsylvania on account of the tremendous volume of the steel business in this state and the percentage of the power in the steel business as compared with that which is utilized in all other industries in the state. I believe it is a fact that there is as much power in the steel business outside of the central stations as there is in the combined output of the central stations of the state. That is roughly true, I believe.

If this is the case it certainly must follow that a combine or pooling of the resources of these two great branches of industry must necessarily result in economies which can be enjoyed by no other state.

J. R. Reed*: I don't know that I have anything worthy of telling you tonight on this subject. Of course, it is needless for me to say that I didn't know just exactly what Doctor Snow was going to talk about any more than the rest of you did. But the problem which confronts us in the steel industry is that of dealing with the Public Service Companies relative to purchasing power; and it is a very difficult problem. In the first place, as you noticed today, we have a vast amount of money invested down at the Steelton plant. Our trouble in dealing with the light company is due to the attitude that they have manifested, that is they felt that they had all the money invested, which is not the case by any means. The Steelton Plant, as you probably noticed, is almost strictly a railroad plant. Now if the railroads would buy the steel uniformly and constantly why we might be able to work out a contract for the purchase of power along the lines that the light and power companies wish to present. Unfortunately that is not the case. We either are going very strong or we are usually going a little slack. Now when we are going strong we make money fairly satisfactorily; when we are going about 75 per cent we are still sitting comfortably; but when we get down around 50 per cent—if we get down to 40 per cent then it is a question of "Are we making money, or are we losing money?" Now if we have to pay a heavy fixed charge—demand charge—to the power company to pay the interest on their bonds just at the same time when we are wondering how we are going to pay the interest on our own bonds, we hesitate before we sign up for contract. Now that is the position in which we are fixed, and which has made it so difficult for steel companies—large steel companies—to enter into very large power contracts with the power producers. And just how this problem will eventually work out we don't know. There are times when we could purchase power and pay the price, and be glad to do it; and there are other time when we simply can't do it. Thank you.

E. D. Dreyfus*: I have had occasion to work out a great many power problems with the large industries. Now I believe that everyone here realizes that this is all in a friendly spirit; I think that we are here to exchange views and thoroughly understand one another. If we don't do it on this floor we will do it in our private offices; so we might as well come out frankly.

Mr. Reed says that he can't quite understand why the central stations insist on charging a fixed demand or constant rate for a given demand through all times, whereas during times of depression the steel industries and other concerns have difficulty in meeting their own fixed charges. Now, I think anyone who has listened to Doctor Snow's paper realizes that the Public Service Companies are being rather closely regulated.

In being regulated it is not possible for a public utility concern to build up any large surplus. They cannot exact any large profits, they are allowed a reasonable rate of return, as Doctor Snow very plainly brought out. On the other hand, I would like to ask Mr. Reed if there is anything surrounding the steel industry that prevents it from making large profits during any stage of its operations so that it might build up a surplus to take case of these contingencies? And, furthermore, isn't it true that if you contract with a power company for a given amount of power that the utility company is relieving you of the investment which you say you must carry, that is providing they

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*Electrical Engineer, West Penn Power Company, Pittsburgh, Pa.

are furnishing you steady and reliable power, which a majority of the large companies are doing these days? The entire subject, of course, is a very interesting one. While I am on my feet, if I may continue, Mr. Chairman, I would like to say just a few words with regard to the statement Mr. Petty made. He said that he was surprised that Doctor Snow had not said something more with regard to rates for the large power user; he said more about the smaller users. Now, as a matter of fact, it has been my experience that the majority, if not all, of the complaints with few exceptions are centered upon the higher rates that are published—10c as compared with 1½c that the big companies earn—the majority of the users pay the high rate and they feel that they have been discriminated against. The question of rate structure is somewhat complicated, but there have been volumes and volumes of information published on that subject which I am sure would be available to this association and its members. But it is quite apparent on the other hand—and they actually do it—that the big industries are quite able to take care of themselves. Aren't they in this position, that if the rate which the public utility offers to them, and makes a part of their published tariff, is not sufficiently low to attract them they put in their own power plant? And we have any number of instances where we have great difficulty in proving that our published rate is reasonable, or sufficiently low to attract their business.

Now, I am coming to one other point that I am going to discuss just a little bit on the floor with you gentlemen. When we talk about rates and power — you gentlemen carry this home with you—when we figure out what we can put a power plant in for we think more about the ideal efficiency. We forget our deficiencies and discrepancy losses which always make the actual results a considerable percentage higher than the ideal. So that you men here are always using the whip hand over the utility, and the utility has constantly got to strive and perfect its position in order to secure your business. Gentlemen, I thank you.

C. H. Hunt*: We, of course, generate all of our own power at the present time. There are a number of big power plants installed and building in our districts which may change our attitude later on.

I have always believed that the large central station or super-power system could be of real benefit to the steel industry, particularly the smaller isolated plants, and plants where blast furnace gas and waste heat are not available, and should be able to make contracts and furnish satisfactory guarantees for long periods of service at rates which would be less than power can be produced by smaller independent power stations at the plants where fixed charges on the investment are added to the operating costs.

However, we have not as yet been able to secure such contracts, and about five years ago found it to our advantage to install additional generating equipment to supply power to one of our plants which had previously been using purchased power, and have paid for the cost of the installation several times in the savings effected over the price we had to pay, or for which the contract could be renewed for purchased power.

I want to take this opportunity, however, of expressing my appreciation of the trips that we have had today and the papers that have been presented this evening, and also the discussions.

Mr. Stoltz has questioned our steam costs. The costs used were higher than the costs at which we produce steam. Possibly, I have also made the cost of power higher than it should be figured. I think there is 1.13c in favor of the engine drive in our case, which we could still concede to the motor because we still have our difference of cost of investment in our favor. I could not help but notice the chart Mr. Stoltz has shown comparing the twin simple non-condensing engine with the turbo generator electric driven mill, whereby the water rate on the boilers was so high when the load was off, and it seems to me the boilers must not have been equipped with draft regulators for cutting down the rate of firing when there was no steam demand. I think that would also answer some of these questions on standby losses. If the standby losses were as great as indicated, a good portion of that loss would still be present when the electric driven mill was down, as over a period shut down the boiler plant could be slowed down or banked in one case as well as the other in case the boiler plant was used only to supply steam for the mill drive as is assumed in this case.

Several people have been remarking about hearing the mill a mile away when driven by engine. I used to live in Youngstown and resided about a mile from an engine. I have listened to my window sash rattling in response to the engine reversals many times but I question whether that was due to the engine but rather due to the excessive clearance of the old style wabbler spindle couplings and back lash of straight tooth cast pinions. One other thought I have to offer—I believe the motor and the engine each have their proper place, most certainly not the old simple non-condensing engine but a well designed compound condensing or Unaflow engine, and it is a subject on which anyone who is contemplating a new installation or change in existing drive, would welcome actual results and true and fair comparisons of both types of drives, this is what I hope will be the outcome of these discussions.

There is one thing that the officials of any company are interested in as much as these items of cost, that is that the mill should go along day in and day out and roll the tonnages they require. I know the motor does that and so far our engine has done it, often under maximum demand conditions. We have been able to meet the demands of the finishing mills for tons of steel at all times, and I think our people are satisfied with the engine. Our mill superintendent, who has operated both engine driven reversing mills and motor driven mills, claims his best records were made on engine driven mills. Just a few days ago, he made the statement that no matter what demand for tonnage was made upon his mill, he did not feel his drive was going to limit the tonnage produced.

Dr. Stine*: Chairman, and Gentlemen: I am in no sense a technical man, but this discussion interests me very much. I agree very thoroughly with some of the points that Mr. Dreyfus has brought out. He has been a very valuable member of the Pennsylvania Electric Association. He has established the geographic sections meetings, which have been a wonderful success, and has promoted better fellowship among

*Chief Engineer, Weirton Steel Company, Weirton, W. Va.

*Pennsylvania Electric Light Association, Harrisburg, Pa.

the personnel of our organization than any one man, I think, in the association. As he states, the manufacturing corporations do enjoy certain privileges that the utility companies do not have. You are looking at the question largely tonight, I think, from a manufacturer's standpoint. The utilities, if you remember, are subject to state taxation. The manufacturing corporations, which perhaps some engineers don't know, are relieved of that burden. They can, as Mr. Dreyfus has very aptly said, accumulate a surplus for the lean years. That, however, is not the real important purpose of my talk tonight. I think that the whole question resolves itself down to that of a better understanding as between one organization and another organization.

Not very long ago we had a serious controversy with the telephone company — the Bell Telephone Company—and the American Telegraph & Telephone, with respect to the joint use of poles, which threatened to develop into quite a serious problem for the utility company in the matter of increased expense in erecting pole lines instead of making it a joint proposition. And the idea was conceived of inviting the telephone men to our convention, which is held every year at Bedford. The result of that was a wonderfully better understanding between the two interests. There were, I think, 10 or 12 telephone men who attended that convention the first year; the last year there were 60 there. They have come to regard it really as almost part of their own convention. They are just the same good fellows that the Pennsylvania electric men are, and the result has been that there is a growing and a better understanding between the two associations which I believe will bring about all the results that are desired with respect to the joint use of poles.

I would suggest that probably the same method be applied in connection with this question of load factor and the ready-to-serve charge. Let some of you people come out to our Bedford convention and see how seriously our organization is engaged in taking up and trying to solve these problems. Take part in the discussions; you will have an abundant opportunity to do so, and we will be very glad to have you there. And in that way I think the beginning of wisdom, the beginning of understanding is in a mutual respect and appreciation that the other man is trying to do his part fairly and honestly; and I think that if you get down to that as the basis of it, why we will get together on a whole lot of these questions that probably in the spirit of resentment, or a little spirit of misunderstanding we might fight and quarrel about. So that on behalf of our association I am going to extend to you an invitation to come out there in the early part of September, as many as who can, and just see what we are doing and bring up some of these questions, and let us all try and hear how to solve them.

G. H. Schaeffer*: Mr. Reed has made a remark as to the rates when business is good and when it is poor. The thought that has been thrashed into my mind at the plant is that the steel business is either a feast or a famine. I think that executives of all companies are very willing to pay a good price for power when needed, and that is—when business is good. As to the suggestion of setting up reserve funds to pay for the increased power when business is poor, I think that that is away up in the air. I believe that every steel company has a reserve fund, and very often they need that reserve fund to take care of operating contingencies, labor, and many other things. The Super-Power Survey, as I understand it, is going to result in the saving of millions of tons of coal. I haven't heard much said as to who is going to derive the benefit of that great saving. I would like to ask Mr. Dickerman whether they have estimated how much that is going to reduce the cost of power to the steel companies? I would like to ask for an explanation from Doctor Snow whether there are any clauses allowable for increases of rates due to labor increases. We have increases of rates due to the fluctuation in the price of coal, and demand factors; and I believe in some cases there are clauses which take care of labor increases. I will say one more thing, and that is, I wish that the steel companies could get any old price that they liked for their product, for if we could I don't believe that we would have to put up that reserve fund.

Colonel H. C. Demming*: Thirty years ago this month the courts of Dauphin County and the State Supreme Court were deciding the question whether an electric power plant was a manufacturing concern or not. And an electrical power plant was located at the time about 500 ft. from where you are now sitting. During that investigation leading experts on electricity were called in as witnesses. Before everything was completed the investigation had gone so far that the basic principles of the radio were discovered. These investigations have been going on ever since; but even now there is something very peculiar in regard to the radio that no man on the face of the earth has explained.

It may be of interest to you gentlemen to know that during the presidency of A. J. Cassatt, of the Pennsylvania Railroad Company, an investigation was made of the possibilities of the Susquehanna River and its tributaries in regard to electrifying the Pennsylvania Railroad Company's transportation. Reports were made to the extent that enough electricity could be obtained through the Susquehanna River and its tributaries to move 12,000 freight trains, of 100 battleship cars, each train loaded to the extent of 50 tons per car, at the rate of 19 miles per hour on a level, all moving at one time. That report has never been put into public print.

Before I sit down there is another subject that I think will interest you. It is that we are now engaged in Schenectady, New York, and elsewhere, in determining what causes the blue color of the sky; and we are gradually reaching the conclusion that it is on account of the numberless electrons, and that the so-called ether of the atmosphere is all a myth.

Dr. F. H. Snow: The gentleman from Pittsburgh asked if there were any rules or regulations covering the case of an industrial plant closed down where the demand charge continued. In addition to what I have said briefly tonight, anyone particularly interested in demand charges should read my detailed paper which has been prepared for publication. It has cost in time and money many thousands of dollars to get these

*Supt. Electrical Department, Carpenter Steel Company, Reading, Pa.

*Colonel Henry C. Demming, a quaint and versatile veteran of three wars, 81 years of age—a Mining Engineer, Mineralogist, Geologist, Chemist, and Official Stenographer of the Courts of Fulton and York Counties.

determinations from the commission and the courts and they are controlling. It makes no difference whether the case were a small one or a large one as to the determination of the principle of the law deduced therefrom. The interested individual will find in the detailed paper very thorough treatment of the matter of contractural relations between the consumer and the producer. The Public Service Commission does not attempt to function as the manager of your business enterprises, and this you will find very plain in the decisions of the commission and the courts. These decisions have attracted the attention of producers and consumers throughout the country. The Pennsylvania Commission is known as a conservative commission. It has attempted to "keep off the grass" so far as managing the business of public service companies is concerned. When you read my paper you will find that therein it is brought out very distinctly that only in so far as the public is concerned with respect to contracts, in so far that the rates shall be reasonable, that they shall not be discriminatory nor preferential, does the state undertake to exercise its regulatory power. Outside of these salient features, you as producers and users have all the rights that you ever had to make contracts.

It is not the business of the Public Service Commission, judged by its practice thus far under the law, to say to you primarily what is the right way to have a demand charge or any other charge, provided, as stated above, the rates are reasonable and non-discriminatory and non-preferential. Contracts that were in existence prior to 1913, have been taken by the commission, and the courts have sustained the commission in doing so, as evidence of what is a fair and right measure of rates as expressed in contracts. I do not know how at the present time it is possible to standardize such things as demand and ready-to-serve charges. They are business matters and different as the circumstances differ. Who shall make the terms of contracts except the parties of interest? If the industrial consumer or any other large consumer desires to be classified as such and the producer is willing to make the classification, it can be done by contract; but to make this contract legal, the rates must be put in a tariff and must be posted, published and filed as provided by law and the rules of practice of the commission; but there can be as many classifications as there are need for them in justice and equity, although I might add that it is coming to be understood by those engaged in this kind of business that simplified tariffs are the best kind of tariffs.

In the matter of interchange of current between one company and another producing electric energy, the parties are free to make contracts and to settle such affairs between themselves; in this way the commission not being concerned and not passing upon that kind of a contract except that any rates specified therein should be posted and filed in the regulatory manner.

It is my own conception at this time, at the end of the first 10 years of the commission's existence, that if the State were to undertake to standardize such things generally, it would defeat the very purpose of the law which is to prevent undue discriminations, preferences, etc., so that apparently it is up to you, gentlemen, the large users and producers, to agree as to terms and conditions of contracts. As the rendering of electric service to the public expands, a different situation may develop in some respects and require special treatment.

I cannot this evening tell you just how any specific case should be treated. I would have to know all the circumstances in order to give a proper answer and that is why the law provides that the Commission shall hold hearings and decisions shall be based upon the record and be subject to appeal to the courts. The Commission itself must try cases on their merits and all the essential circumstances must be known before the Commission can say whether service charges and demand charges, etc., are just and reasonable and in what form they shall be allowed where there is a contest.

The Giant Power study being made by the Pinchot administration may result in the consummation of a project ultimately that will affect the settlement of some of these problems in a broad way but that subject cannot be discussed at this moment.

Mr. Schaeffer asked about the labor clause. You all know that during the war there were war surcharge clauses, war labor clauses and coal clauses in tariffs. They served their immediate emergency purpose satisfactorily in the main to all concerned. Their legality was never passed upon. After the emergency had passed it seemed better in all respects to have those emergency clauses discontinued and substituted by the distribution of charges throughout the rate structure and this is now the rule.

In one of the small cases to which I referred tonight, it was made apparent that a producer or a consumer cannot ask and expect to obtain the advantages of classification unless there are good and sufficient reasons for the classification and the rates under the classification must be set up and clearly appear in the tariff; otherwise, they will fall and be stricken out when the issue is brought before the Commission or the courts. I think this answers the questions propounded.

J. C. Dickerman: One of the gentlemen inquired about when information such as that map (pointing to the map from which he had previously spoken) would be available. The Survey Board is required to make a formal report to the Legislature at the next session in January, 1925. Preceding that, the data which we have will probably not be published; but we expect our report to contain reduced prints of a great many diagrams, maps and so forth covering the consolidated data which has been gathered relating to all those matters of interest to the Survey.

Another gentleman asked about the savings—where the savings were going to. If you will note my paper you will see that one of our anticipated benefits in the carrying out of the Giant Power Survey program, as we at present conceive of it, is that there will be a general lowering of costs to consumers, including the steel people, who patronize the public utility. I cannot state in any form at all—in mills—what the rates would be; that isn't a part of our story as yet; but if you will watch that report when it comes out next January you will probably see some estimates based on very careful studies which our engineers have been making which may give you a little more light on that.

Mr. Quentin*: Mr. Chairman, the Duquesne Light Company was very fortunate about a month or so ago in closing a contract for the supply of power

*Dupuesne Light Company, Pitsburgh, Pa.

to a new 14-in. structural mill which is being installed in their Aliquippa Works at Woodlawn by the Jones & Laughlin Steel Company. The connected load of this plant is about 17,000 kw., and the demand may reach 9,000 kw. The load factor is estimated to be somewhat less than 40 per cent per month, and under these conditions the rate will average about 11½ mills per kwh. This, we hope, will prove only the initial development of this plant. If so it is going to mean a large source of power for central stations and incidentally a correspondingly large source of power to the central.

The negotiations for this business were built around a plan for interchanging power with the Jones & Laughlin Company to an extent of about 5,000 kva. for periods when we need it, or when they have an excess amount of power. The initial capacity of lines and switches that we are putting in is about 12,000 kva.; and if this connection works out as well as we all anticipate we know that further electrification will follow in this plant, which now is using something over 50,000 kva.

W. Burr*: We have been greatly favored this evening in having the privilege of holding this meeting in the House of Representatives. We are indebted to the Governor for the privilege, and I am sure that as an association we feel that we have been helped greatly in our meeting and that we owe him a vote of thanks. Mr. Petty, if you will now offer your motion——

D. M. Petty: I move that we offer a rising vote of thanks to the Governor for the use of the House of Representatives, and to Doctor Snow and Mr. Dickerman for their talks.

Members all rose to their feet in a rising vote of thanks as mentioned by Mr. Petty and seconded by George B. Quentin.

*Electrical Superintendent, Lukens Steel Company, Coatesville, Pa.

IRON *and* STEEL EXPOSITION

Million Dollar Show

Duquesne Garden, Pittsburgh, Pa.

SEPTEMBER 15th-20th, 1924

"The Billion Dollar Market"

Electricity - Machinery - Power
Combustion - Mill Builders

Have You Made Your Application for Space?

Floor Plan on Page 407

Write to Association of Iron & Steel Electrical Engineers,
706 Empire Building, Pittsburgh, Pa.

LIST OF EXHIBITORS
IRON AND STEEL EXPOSITION
September 15-20, Pittsburgh, Pa.

Name	Booth
Allen Bradley Company	116
Alliance Machine Company	82
Allis Chalmers Manufacturing Company	68
Appleton Electric Company	111, 118
Automatic Reclosing Circuit Breaker Co.	21
American Engineering Company	159
Baker R & L Company	93, 94, 95
Bartlett Hayward Company	84, 85
Benjamin Electric Manufacturing Company	79
W. A. Bittner Company	56
Bussmann Manufacturing Company	115
Bacharach Industrial Instrument Co.	39
Chicago Fuse & Manufacturing Company	22
Chicago Pneumatic Tool Company	15, 16
Corliss Carbon Company	40
Crocker Wheeler Company	59
Crouse Hinds Company	90, 99
Cutler Hammer Manufacturing Co.	74, 75
The Cutter Company	13
The Calorizing Company	47
Detrick Arch Company	53
Doubleday Hill Electric Company	72
Dravo Doyle Company	150
Duquesne Light Company	36, 37, 38
Economy Fuse & Manufacturing Company	35
Electric Controller & Manufacturing Co.	80, 81
The Electric Journal	134
Electric Service Supplies Company	50, 51
Electric Storage Battery Company	46
Fairbanks Morse Company	112, 117
Fuller Lehigh Company	32, 33
Farrell Foundry & Machine Company	96, 97
General Electric Company	120 to 129
The Hayward Company	135, 136
Ludwig Hommel & Company	110, 119
Hyatt Roller Bearing Company	69
Homestead Valve Manufacturing Company	44
Hagan Corporation	3, 4, 5, 6
Iron City Electric Company	45
Jos. Jacques	145
Johns Manville Company, Inc.	75
W. A. Jones Foundry & Machine Co.	113
Keystone Lubricating Company	57, 58
H. Kleinhans Company	142, 143, 146, 147
Lakewood Engineering Company	28
Morgan Engineering Company	66, 67
Mutual Electric & Machine Company	19
McGraw-Hill Company	11
C. H. McCullough Engineering Company	25
National Carbon Company	89
Norma Company of America	158
New Departure Manufacturing Company	137, 138
Ohio Electric & Controller Company	18
Otis Elevator Company	29, 30, 31
Packard Electric Company	60, 61
Pittsburgh Electric Furnace Corporation	70, 71
Pittsburgh Transformer Company	23, 24
Pyle National Company	41
Pittsburgh Electrical & Machine Works	64
Payne-Dean, Ltd.	76
Wm. Reed Engineering Co.	132
Railway & Industrial Engineering Company	98
Republic Flow Meter Company	54
Rollway Bearing Company	17
Rutherford & Uptegraff	62, 63
Reliance Electric & Engineering Co.	140, 141, 148, 149
Rowan Controller Company	157
Square D Company	20
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Standard Underground Cable Company	73
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Thomas Flexible Coupling Company	131
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Trumbull Electric Manufacturing Company	52
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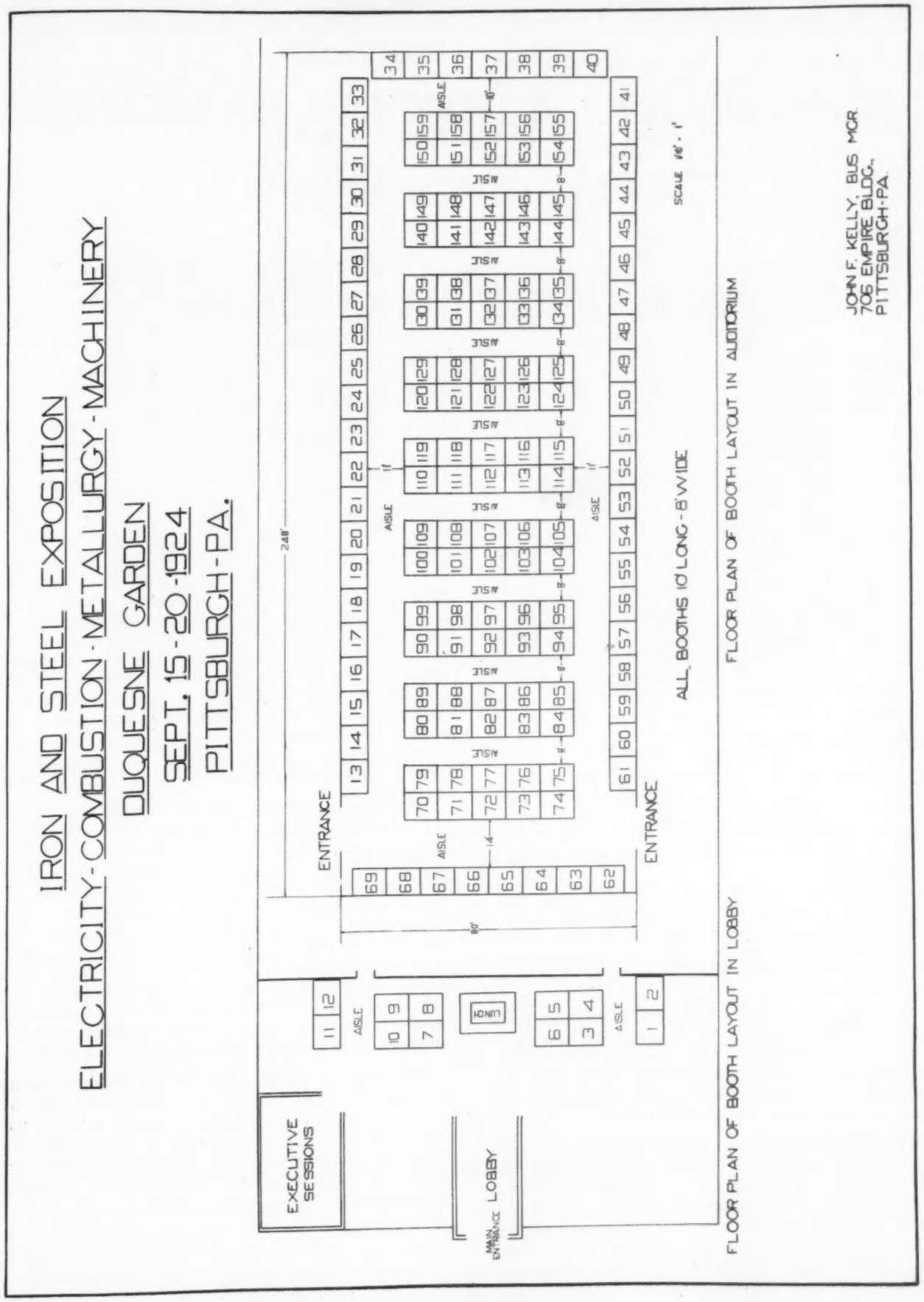

IRON AND STEEL EXPOSITION
ELECTRICITY-COMBUSTION-METALLURGY-MACHINERY
DUQUESNE GARDEN
SEPT. 15-20-1924
PITTSBURGH-PA.
EXECUTIVE SESSIONS
MAIN ENTRANCE LOBBY
LUNCH
AISLE
ENTRANCE
240'
80'
ALL BOOTHS 10' LONG-8' WIDE
SCALE 1/16" = 1'
FLOOR PLAN OF BOOTH LAYOUT IN LOBBY
FLOOR PLAN OF BOOTH LAYOUT IN AUDITORIUM
JOHN F. KELLY, BUS MGR
706 EMPIRE BLDG.,
PITTSBURGH-PA.

BENJAMIN G. LAMME

(Continued from Page 368)

in accordance with them. His success in that line might be described as the foundation for the success of the Westinghouse Electric Company and it has influenced and exhilarated the development of electrical apparatus the world over. His success is also attested by the fact that more than 150 patents have been granted to Mr. Lamme, individually.

Scarcely six months after entering the employ of the Westinghouse Company, he calculated the electrical design of the double reduction gear railway motor, which was put on the market early in 1890. This was very similar in design to others that were in use at that time, so his work showed little more than an ability to calculate the magnetic circuit and for determining the saturation curve.

In the summer of 1890, however, Mr. Lamme began work on the design of a street car motor with but a single gear reduction. This was the forerunner of the celebrated Westinghouse No. 3—a motor that set a standard for street car motors that still persists. It was radically different from anything that had appeared previously, and its success when put out early in 1891 was instantaneous.

At this same time he was working on direct current arc machines and alternating current generators, making improvements in the latter which increased their output by 50 per cent. In 1892 he began work on the induction motor and produced the first successful distributed winding motor of this type. In 1892 Mr. Westinghouse took the contract for lighting the World's Fair. Great polyphase generators had to be designed for this purpose, and Mr. Lamme did the work. He also designed the synchronous converter, large induction motor and other machines which were exhibited at the fair. At this same time, he was designing railway generators whose performance was the boast of the Westinghouse Company.

Then came the Niagara Falls power development, for which Mr. Westinghouse took the contract for the electrical apparatus. The huge umbrella type generators, rated at 5,000 hp. each, were calculated to a nicety by Mr. Lamme, and the machines were a great success.

About the year 1895, Mr. Lamme conceived the idea that led to the development of the well known Type C induction motor with the squirrel cage rotor. Engineers still marvel at the Type C motors and also at Mr. Lamme's paper on induction motors, which is a recognized classic.

His great work on the synchronous converter, however, he regarded as one of his greatest achievements. For years, he fought the battle for the synchronous converter almost single-handed. He won out, as usual, and this is now the accepted machinery for converting alternating into direct current.

Then came his conception of the single phase alternating current railway system. He had long held the belief that the success of heavy electric railroading lay in the use of a high voltage alternating current on a single overhead trolley. He felt that the simplicity and advantage of this system with its simple substations containing nothing but lowering transformers and with no attendants required, were so great that it must come. The main difficulty lay in finding suitable ways and means for utilizing the single phase alternating current. After several attempts, Mr. Lamme succeeded in designing a series commutator type of motor with suitable characteristics, which he described along with the system of power distribution in his famous paper before the American Institute of Electrical Engineers.

The paper created a furore of excitement all over the civilized world and soon every electrical manufacturer was working madly on the problems, and a dozen types of motors were on the market. Mr. Lamme never pinned his faith solely to the commutator type motor, although that is the type that has been most used. He maintained that one of the great advantages of the system lay in the fact that several different types of equipment could be used, all running under the same trolley.

It would seem that the actual design work in connection with all these different types of apparatus and the innumerable other machines with which he has been connected, would have been more than he could handle, but they constituted simply his regular work. He seldom took any of this work home with him, but for 15 years his chief recreation consisted in working and studying over problems and methods of design, spending from three to five hours every night on them.

Mr. Lamme was not a prolific writer, but when he did write, the engineering world sat up and took notice. He had the happy faculty of being able to put his thoughts on paper so that anyone with the rudiments of the subject could understand them. One of his greatest assets was his ability to get a physical conception of every problem and he aimed to give that in his paper. He seldom wrote mathematical papers, although not for lack of ability, but he regarded mathematics as his tools that were to be put away when the work was done. Consequently, his papers are in great demand and are very widely read.

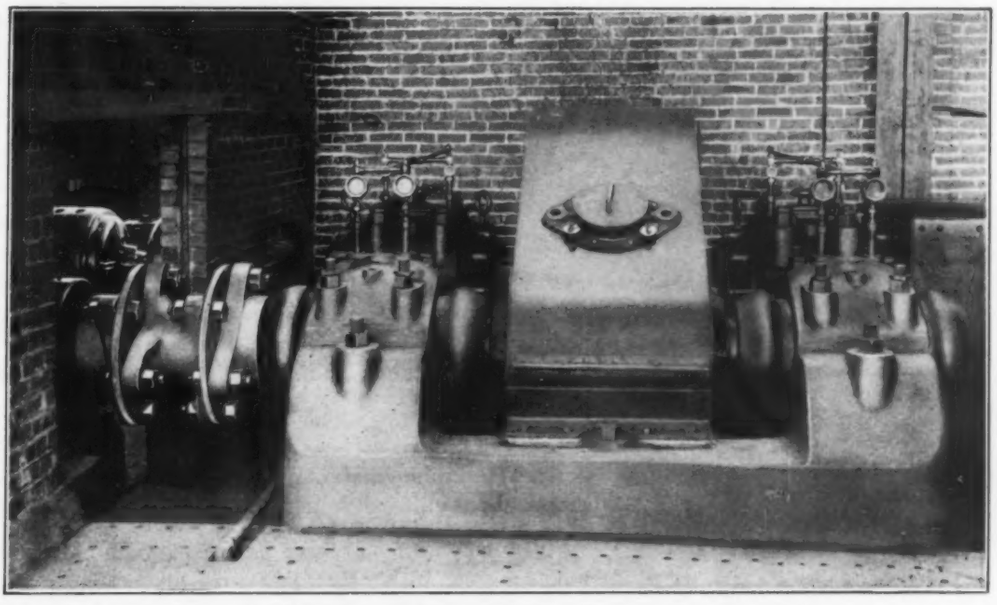
Mr. Lamme has received the highest honors from the American Institute of Electrical Engineers in being elected one of the two members from that body on the Navy Consulting Board during the war and being chairman of the inventions committee on that board. In 1919, he was also awarded the Edison Medal by the American Institute of Electrical Engineers for his engineering achievements. All of these were in consequence of his work and ability as an engineer; he was in competition with engineers only. When the board of trustees of Ohio State University awarded him the Joseph Sullivant Medal it was a recognition of the value of his work to the world.

Designer of many kinds of electrical apparatus, Mr. Lamme's declarations and writings on electrical and mechanical problems were always received with the greatest interest. His greatness as an outstanding electrical engineer can best be judged by the eagerness with which engineers always sought his opinion and discussion.

Mr. Lamme was an honorary member of the Association of Iron and Steel Electrical Engineers, the American Institute of Electrical Engineers and the Engineers Club of New York.

THOMAS FLEXIBLE COUPLINGS

FOR MAIN ROLL DRIVES



Thomas Mill Type Coupling on 12" merchant mill, 1000 H.P., 375 R.P.M.
Buffalo Bolt Co., Buffalo, N. Y.

Examine this view carefully and you will note that the coupling has—

No sliding or wearing parts
No loosely connected members
No frictional resistance to end float
No lubrication
Three very accessible bolts, removal of which frees either end of drive

The Thomas coupling is the only mill spindle which has these features. The first two are the most important, as a "tight" drive eliminates all backlash and prevents the hammering action, which is so destructive to gears, bearings and shafts. The net result is an immediate reduction in maintenance costs.

Thomas Flexible Coupling Co., Warren, Pa.

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That night the good fairy came to Jones

HIS friends tell a story on General Manager Jones. They say one night he dreamed a Good Fairy came to him right out of the book and told him to make a wish. And Jones sat up in bed and shouted:

"I wish I knew a way to get more PRODUCTION!"

Very well, Mr. Jones. Listen to this:

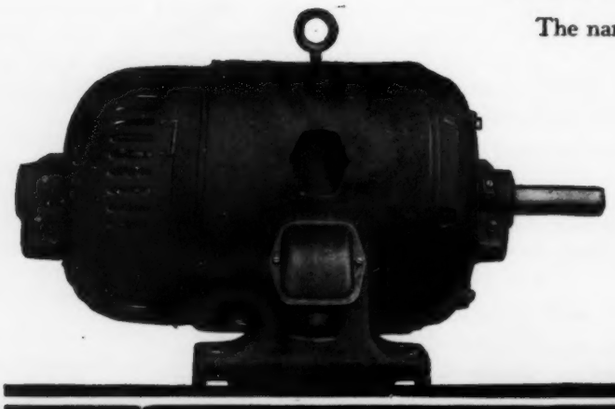
Did you ever think of the effect on production of the speed characteristics of your motors?

You have scores of induction motors driving your machines. The Central Station man isn't any too pleased when you put more of them on the line, and when you complain of poor voltage, he tells you it is due to your bad power-factor. That seems more annoying than serious, perhaps. It hasn't occurred to you that the motors, besides being a trial to the Central Station, are *holding back your production.*

They lag a little in speed all the time; more than a little, a good deal of the time. As the voltage drops you are lucky if they don't stop entirely. The combined effect of the lagging on all the machines in the shop will put quite a hole in the production figures.

Now suppose a motor that operates at synchronism—at a perfectly uniform speed higher than that of an induction motor for the same power input—over practically your entire load range; that starts as easily as an induction motor, and requires no more care; and at the same time, by correcting your power-factor, helps keep voltage uniform. Think of the gain, not only in general efficiency, but in PRODUCTION.

The name of that motor is THE FYNN-WEICHSEL MOTOR.



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The motor that corrects power-factor

WAGNER ELECTRIC CORPORATION
SAINT LOUIS

WAGNER ELECTRIC CORPORATION
You may send me—without obligation on my part—a copy of your bulletin No. 134, describing THE FYNN-WEICHSEL MOTOR.

NAME
COMPANY
STREET
CITY STATE

AIR!

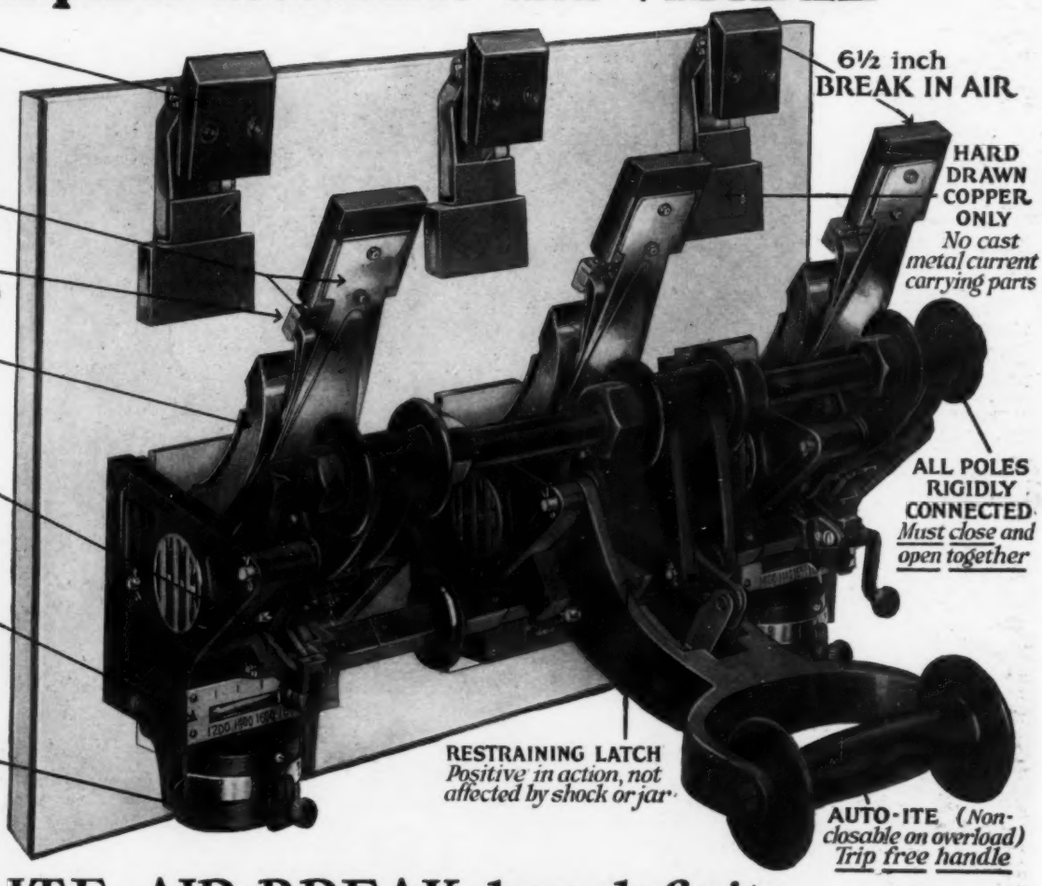
I-T-E CIRCUIT BREAKERS

For Alternating Current

600 VOLTS OR LESS

Give protection without complication

All parts accessible and VISIBLE


COPPER JACKETED PRESSURE CARBONS
For initial contact and final break
Mechanically strong
Electrically perfect
PHOSPHOR BRONZE CARBON SUPPORTS
HEAVY METALLIC SECONDARY BREAKING CONTACTS
LAMINATED BRIDGE
Each leaf individually formed - Heavy even pressure on every Lamination
CLOSING TOGGLES
Afford heavy contact pressure with easy closing
OVERLOAD
Direct acting. Long scale calibration. No relays or series transformers
DALITE
(Direct acting time limit) feature. Adjustable from zero to maximum time. No relays
6½ inch BREAK IN AIR
HARD DRAWN COPPER ONLY
No cast metal current carrying parts
ALL POLES RIGIDLY CONNECTED
Must close and open together
RESTRAINING LATCH
Positive in action, not affected by shock or jar
AUTO-ITE (Non-closable on overload)
Trip free handle

I-T-E AIR BREAK has definite advantages not present in the oil breaker

1. *No oil — to leak, carbonize, burn or explode — Just air.*
2. *No tanks to conceal anything — or the lack of it.*
3. *No cells — nothing which needs or deserves to be imprisoned — Just a faithful and efficient servant.*
4. *Inherent simplicity — with resulting low cost of installation and maintenance.*

The I-T-E CUTTER COMPANY
ESTABLISHED 1888 PHILADELPHIA

A BRUSH OF PROVED QUALITY

Use

N C C

259

On

DC side of Rotary Converters

DC Generators

DC Motors

AC Commutator Type adjustable speed motors where commutators are undercut

and secure minimum commutator wear, cool operation with splendid commutation and consequent increased efficiency.

National Pyramid Brushes

Manufactured and guaranteed by

NATIONAL CARBON CO., INC., Cleveland, Ohio—San Francisco, Cal.

Canadian National Carbon Co., Limited, Toronto, Ontario

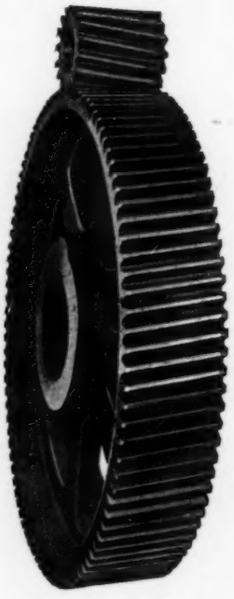
Emergency Service Plants

CHICAGO, ILL.
551 Monroe St.
Phone: STAte 6092

PITTSBURGH, PA.
7th Floor, Arrott Power Bldg. No. 3, Barker Place
Phone: SMIthfield 0740

NEW YORK, N. Y.
237 East 41st St.
Phone: VANderbilt 0425

Nuttall Helical Gears



Even if you offered twenty times their present price *nobody* could make you better gears than Nuttall BP Helicals.

They are vibrationless, silent, highly efficient, their rolling contact minimizes friction and the BP Treatment makes them resist wear.

R.D. NUTTALL COMPANY
PITTSBURGH PENNSYLVANIA

Philadelphia Office
420 Land Title Bldg.

Chicago Office
2133 Conway Bldg.

Nuttall

PANELBOARDS

SAFETY PANELBOARDS PROTECT

THE INQUISITIVE PUBLIC
THE CURIOUS CHILD
THE CARELESS OPERATOR

SAFETY PANEL WITH TUMBLER SWITCHES

Safety Panels allow the unrestricted operation of the circuit switches without the possibility of the operator or other persons coming in contact with any live parts. These parts, with the fuses, are accessible only to an authorized person who has a key to the separate locked door over the fuse compartment. The door over the switch compartment may also be locked if desired.

Safety Panels are furnished with either tumbler or double push button switches in the branch circuits.

SAFETY PANEL WITH DOUBLE PUSH BUTTON SWITCHES

CH 121

For further information write for Bulletins 1D and 1F

CROUSE-HINDS COMPANY

SYRACUSE, N. Y., U. S. A.

DISTRICT SALES OFFICES

NEW YORK BOSTON CHICAGO

SALES OFFICES

PHILADELPHIA DETROIT CINCINNATI ST. LOUIS MINNEAPOLIS SAN FRANCISCO

CROUSE-HINDS

"It saves taking from 5 to 10 men away from other work"

THAT'S the experience of the Warren Mfg. Co. with their Baker Elevating Truck on one operation alone at the Milford, N. J., plant.

They have to spot freight cars there several times a day. Formerly this meant taking 5 to 10 men away from other jobs on which they were working. With the help of the Baker ***2 men*** now do this work much more quickly than a large gang of men.

The largest use of the truck, however, comes after the car is spotted. The Baker serves faithfully from morning to night—transferring pulp from cars to storehouse and about the plant.

A great deal of heavy work and expense is also saved in moving the pulp to the various points in the mill where it is to be used, and in handling lime, alum and other raw materials.

Baker Industrial Division
THE BAKER R & L COMPANY · CLEVELAND, OHIO

Not Exhausted By Hot Weather

UNLIKE hand labor, the electrically operated industrial truck maintains its efficiency throughout the hottest of dog days as well as through the drafty hours of winter.

Regardless of weather conditions, the Baker goes quietly about its business, transporting material in process up steep ramps, down narrow aisles and around sharp corners with a decided economy in time, expense and man power.

The easily maneuvered elevating truck slides its low platform under an independently loaded skid, raises it in 10 seconds and quickly carries it to the next process.

The majority of Baker installations pay for themselves within six months —all further saving is pure profit. Our catalog describes all models, and Baker engineers in 35 conveniently located sales offices are always glad to recommend the most suitable type for particular conditions.

THE BAKER R & L COMPANY
Cleveland, Ohio

ELECTRIC TRACTORS AND TRUCKS
TRADE-MARK REG. U.S. PAT. OFF
Baker

When the boss asks "Where does this power go?"—

CAN YOU ANSWER?

MODERN business management keeps close tabs on departmental costs. In industrial establishments where power is a considerable item, it is poor business to charge power costs to the general overhead.

Installation of watthour meters on main electrical feeders entering each department; or furnishing energy to the motors driving each bank of machines; or supplying electricity for an individual process, is an invaluable aid for the detection of power waste as well as for correctly charging to each department or process its proper share of general costs for electric energy.

Surprising savings and discoveries have been made by many industrial concerns who have adopted this practice and installed Sangamo Meters.

Sangamo Watthour Meters are ideal for industrial service. Simple, sturdy, dependable, they stand the shock and jar of industrial manufacturing operations—can be successfully installed and maintained by average electrical mechanics—and can be relied on to perform their function with the sustained accuracy so essential to correct allocation of power costs.

Write for special bulletin describing this meter.

Sangamo Type-D5
Direct-current
Watthour Meter

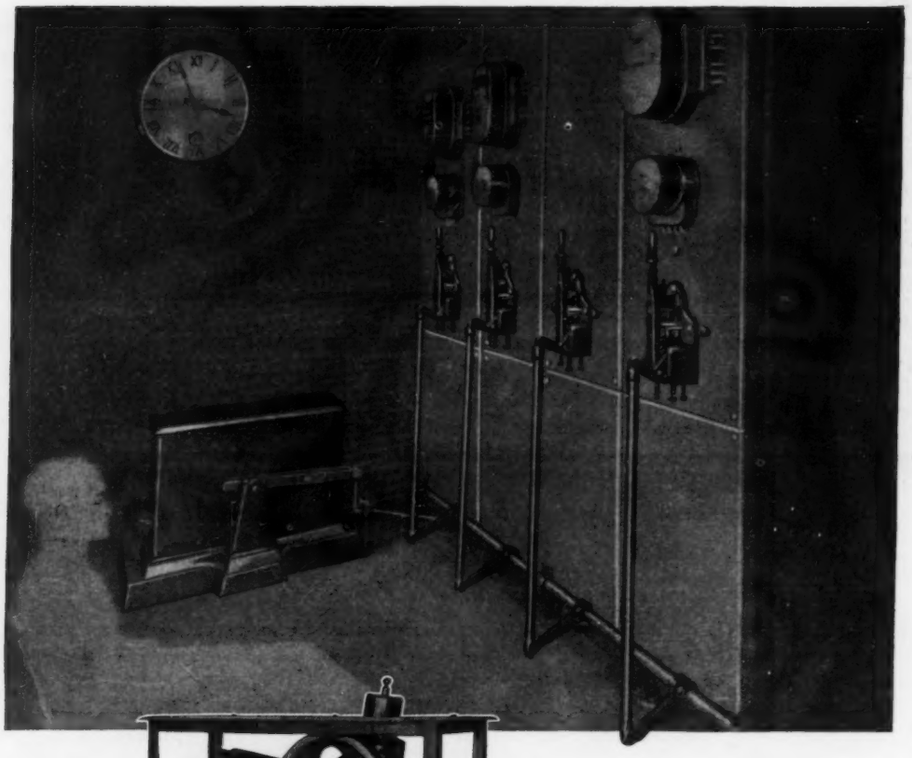
SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

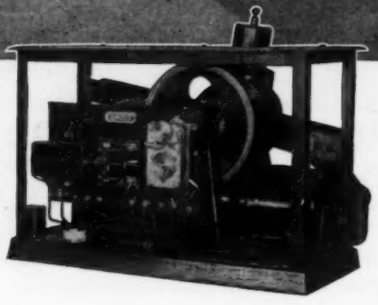
New York Chicago Birmingham San Francisco Los Angeles

SANGAMO METERS

FOR EVERY ELECTRICAL NEED

0820-3





The Invisible Operator

Always and ever, the Condit Automatic Reclosing Mechanism stands watch on your remote indoor or outdoor sub-stations. Years of service have conclusively proven its reliability. One machine, operated by a fractional h. p. motor, controls a number of feeders.

When a circuit breaker opens from overload or short-circuit, the Condit Automatic Reclosing Mechanism operates instantly—far quicker than the average operator could possibly act—reclosing the circuit or circuits. Once, twice or three times—if the short or overload persists—this more than human device recloses the breaker or breakers that have opened.

The Condit Automatic Reclosing Mechanism—working as it does from a fractional H. P. motor on A. C. circuits—affords tremendous possibilities for reductions in operating expense, insures never failing attendance to the feeders, and reduces service interruptions to the minimum. Send for Bulletin No. 456.

Get in touch with Condit

CONDIT ELECTRICAL MFG. CO.

Manufacturers of Electrical Protective Devices

South Boston, Mass.

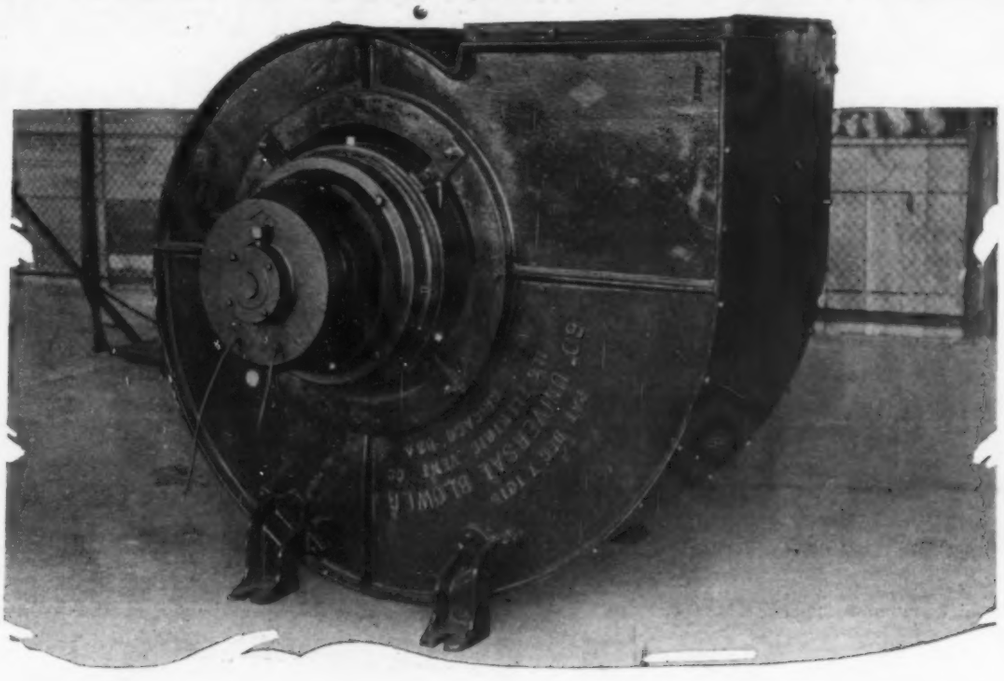
Northern Electric Company LIMITED

Sole Distributors for the Dominion of Canada

7010

CONDIT

SKF



Ball Bearings Insure Continuous Service
Of Direct-Connected Motor Blowers

RELIABILITY of the bearings and their freedom from the necessity of frequent attention are two vital factors affecting the service derived from blowers, especially as this type of equipment is often so placed as to be inaccessible and therefore subject to neglect. Skayef Self-Aligning Ball Bearings on the motor of this direct-connected sixty-inch blower eliminate all possibility of shutdowns for bearing adjustments or renewals at critical periods.

Despite the heavy load, the motor bearings run smoothly and quietly with a minimum of friction and wear. Destructive vibration is eliminated and the motor armature is kept permanently in correct position.

THE SKAYEF BALL BEARING COMPANY

Supervised by SKF INDUSTRIES, INC., 165 Broadway, New York City

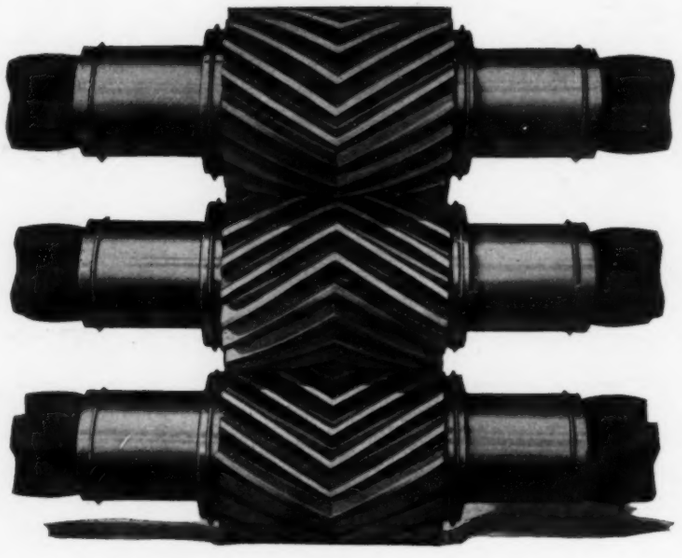
1209

Normal View *Deflected View*

SYKES MILL PINIONS

CONTINUOUS HERRINGBONE TEETH

——MACHINE CUT——



Generated from the Solid Forging or Casting
20° Pressure and 30° Helical Angles
Bearing Surface Across Entire Face Width
Strong Tooth Profiles No Undercut

FARREL
SYKES GEARS

THE GEAR WITH A BACKBONE

FARREL FOUNDRY & MACHINE CO., Inc.

BUFFALO, N. Y., U. S. A.

"BENCO"

Weather-Proof Socket for Heavy-Duty Industrial Use

Bencos are the favorite general service sockets around industrial plants. Exceptionally adaptable to the severe requirements of mills, foundries and other departments of the metal-working industry.

They have a highly insulated rugged interior and a strong metal casing. Type S Reflectors, including Bowl, RLM Dome, Shallow Bowl and Angle, attach directly to Benco Sockets.

NEW PRICES— Several numbers of the Benco Weather-Proof Sockets have recently been specially priced, owing to large production enabling us to affect savings in cost. Write our nearest office for new bulletin.

Benjamin Electric Mfg. Co.

847 W. Jackson Blvd., Chicago

247 W. 17th Street, New York

580 Howard Street, San Francisco

BENJAMIN

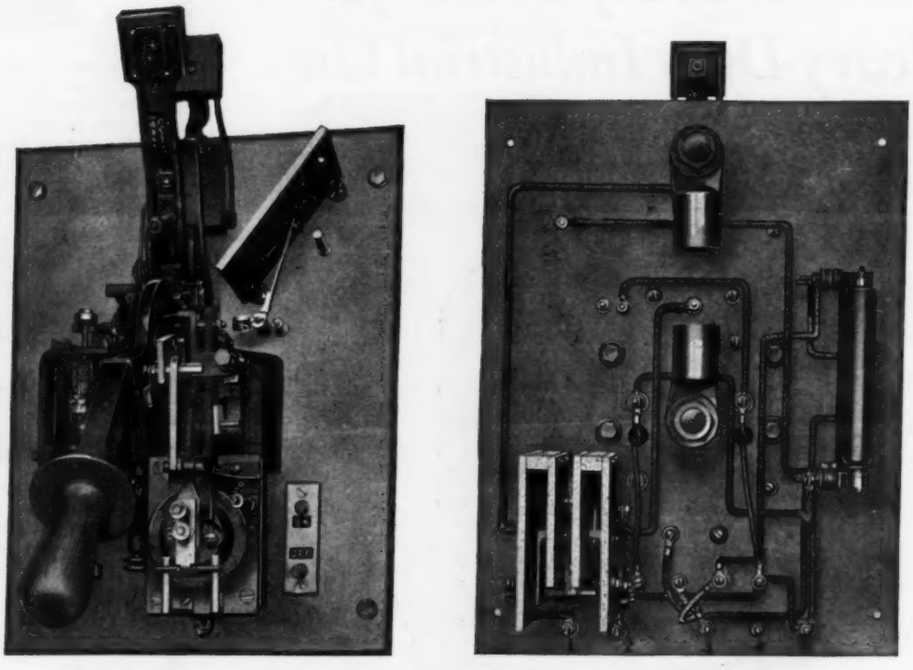
Makers of Things More Useful

Keyless. Porcelain interior. Tapped for ½-inch and ⅜-inch Iron Pipe Connection. Casings are of Aluminum, Copper or Brass. Finished in Polished Aluminum, Brushed Brass or Natural Copper.

Keyless. Porcelain interior. Brushed for Drop Cord up to ½-inch diameter. With strain relief effective on 16-gauge and larger conductors. Casings are of Aluminum, Copper or Brass. Finished in Polished Aluminum, Brushed Brass or Natural Copper.

Pull Chain. The "inner pull" is a big feature. Weather-proof. Chain action unobstructed. Molded Composition interior and Benjamin Lamp Grip. Tapped for ½-inch and ⅜-inch pipe connection. Casings are of Aluminum, Copper or Brass. Finished in Polished Aluminum, Brushed Brass or Natural Copper.

A Manually Operated Circuit Breaker
That Recloses Automatically



Front and Rear Views, Type "AHM" 600-Ampere Automatic Reclosing Circuit Breaker
With Removable Handle for Manual Operation

or

An Automatic Reclosing Circuit Breaker
That May Be Operated Manually

either way

This Circuit Breaker Embodies All That Is to Be Had in a Circuit Breaker
and Assures You High Grade Circuit Breaker Protection
At All Times and Under All Conditions

With That Refinement in Service That Can Be Had Only With

The Circuit Breaker with Brains

Bulletin 314-F Gives Details.

THE AUTOMATIC RECLOSING CIRCUIT BREAKER CO.

COLUMBUS, OHIO

PITTSBURGH: 1815 Oliver Bldg.
ST. LOUIS: 401 National Bank of Commerce Bldg.
WILKES-BARRE, PA.: 816 Miners Bank Bldg.
CHARLESTON, W. VA.: 317-318 Moore Bldg.

No oil leakage in Strom Ball Bearing equipped motors

Strom Ball Bearings will insure uninterrupted service because the housings can be specially designed for the retention of lubricant. This prevents leaks and entrance on to the insulation and on the armature shaft.

Motors equipped with Strom Ball Bearings need only a small amount of lubricaton. So their maintenance service is reduced to a minimum.

Strom Ball Bearings effect marked reduction of friction, thereby reducing starting and running resistance.

A uniform air gap between armature and coils is maintained because the wear of ball bearings is negligible.

A more compact motor can be designed with ball bearings because of small bearing width required.

They prevent end motion of rotor because Strom Ball Bearings take the end thrust as well as the radial load.

There is a Strom Ball Bearing for every shaft that turns. They are made in a wide range of types and sizes for practically every installation.

Our engineers will be glad to assist in the selection of bearings and in the design of their mountings. Consult them without obligation.

Double-acting thrust bearing, flat seats (grooved races) 2100-F Series

Single-acting thrust bearing, flat seats (grooved races) 1100-F Series

Single-acting, self-aligning thrust bearing 1100 Series

Single-acting, self-aligning thrust bearing, leveling washer. 1100-U Series

Double-acting, self-aligning thrust bearing, leveling washers 2100-U Series

Single-row deep-groove Standard type, radial bearing

Double-row, deep-groove Standard type, radial bearing

Angular contact bearing, combination radial and thrust

Double-row, maximum type, radial bearing

Single-row, maximum type, radial bearing

Strom BALL BEARINGS

Manufactured by

STROM BALL BEARING MFG. CO.

Formerly U. S. Ball Bearing Mfg. Co.

4594 Palmer Street, Chicago, Ill.

"LE CARBONE" CARBON BRUSHES

Standard of Quality and Uniformity

They are supplied not alone to suit type of machine, but your operating conditions.

Guaranteed Without Argument.

Real Engineering Service.

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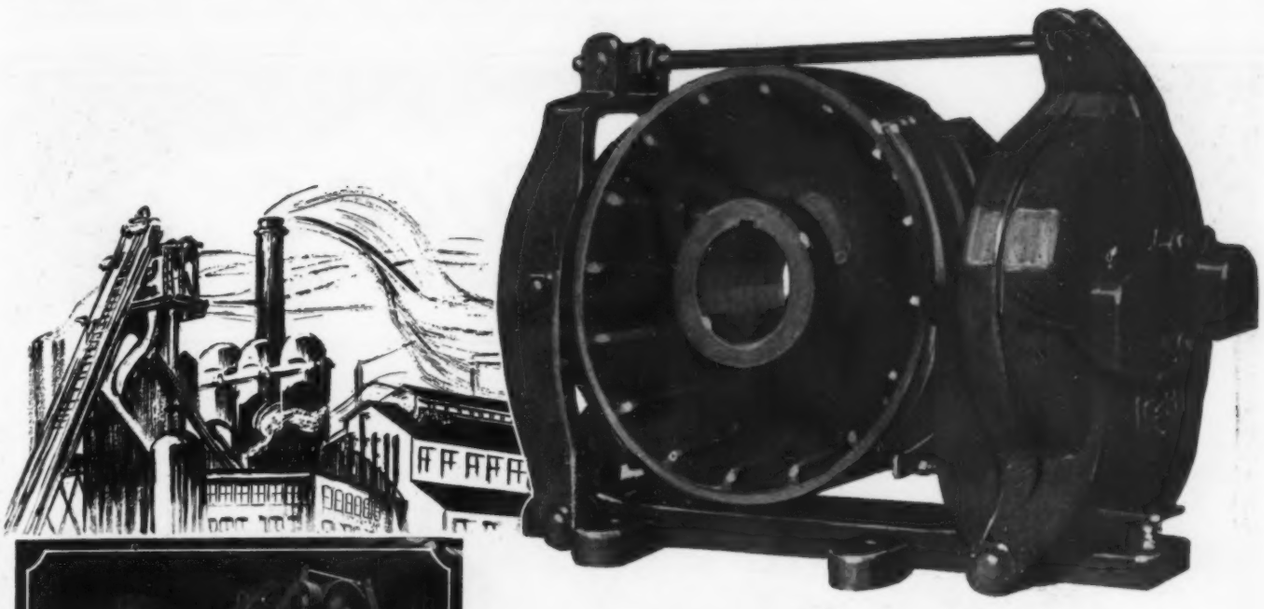
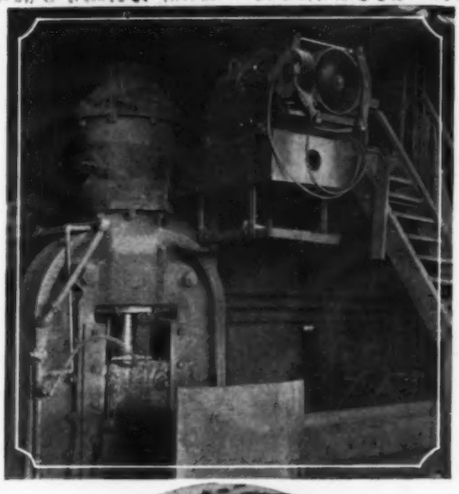
Pittsburgh Office, 634 Wabash Bldg.
W. P. POYNTON, Electrical Engineer

San Francisco Office, 525 Market St.
W. R. CATCHING, Sales Engineer

Chicago Office, 1657 Monadnock Block
A. M. RAMSEY, Sales Engineer

Canadian Distributors: Lyman Tube & Supply Co., Ltd.
Montreal and Toronto





Above, C-H Type M Brakes on screw-downs provide the snappy action desired and withstand the severe frequent service.

Low head-room required is an important factor in crane and hoist work.

Squatty, Rugged, Simple

There isn't a frill on the Cutler-Hammer Brakes—the power, long life and quick action are a direct result of the remarkable simplicity—a distinct Cutler-Hammer achievement.

The magnet action is direct with the operating magnet enclosed in a husky weatherproof, ironclad housing. This direct action eliminates toggles, bell cranks, levers.

The overall height is practically no greater than the brake wheel itself.

The short magnet stroke is the reason for the quick, quiet action which eliminates shock and hammer and the resulting wear.

Thousands in Use

On performance alone, there has developed a demand which has grown steadily until today there are thousands in use and an increasing monthly demand.

Bulletin 850 contains the complete details. Copy on request.

THE CUTLER-HAMMER MFG. CO.

Magnet and Clutch Department
Works: MILWAUKEE *and* NEW YORK
Offices and Agents in Principal Cities
Northern Electric Co., Ltd., Can.

C-H CUTLER-HAMMER

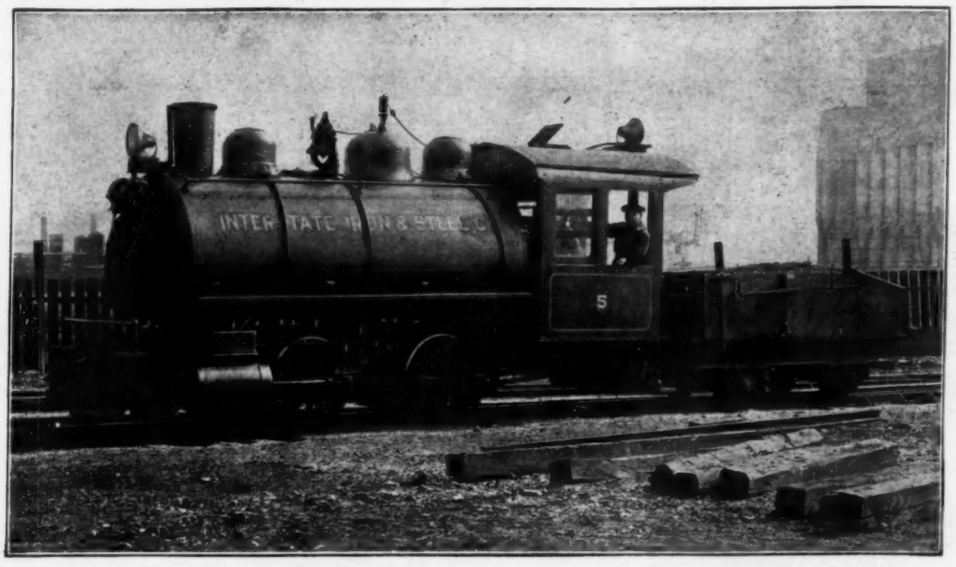
ELECTRIC BRAKES

STORM, RUST & GAS PROOF

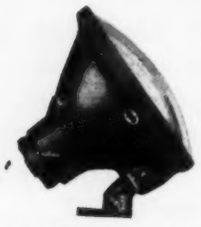
CAST ALUMINUM ALLOY BUILT TO LAST

Pyle-O-Lytes

and STEAM TURBO-GENERATORS



Interstate Iron & Steel Company locomotive equipped with Pyle-O-Lytes, Type 1045-AGB, front and rear and with Pyle-National Type K-2 Steam Turbo-Generator



Pyle-O-Lyte type 1045, widely used for yard lighting around iron and steel plants—one of many Pyle-National floodlighting units. It speeds up night work and increases the efficiency of men and equipment. Cases built of long-lived cast aluminum alloy that will outlast many ordinary sheet metal units—storm, rust and gas proof.

For Every Lighting Requirement of Iron and Steel Plants

FOR either locomotive lighting, or for yard floodlighting, you will find Pyle-National units that exactly meet your needs—efficiently, dependably, and at reasonable cost for installation and operation. The same equipment that lights 90% of the steam railway locomotives in the United States and abroad has proved its dependability for industrial lighting of every nature.

Pyle-National Steam Turbo-Generators

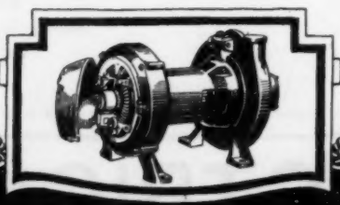
are your most dependable source of current for locomotive lighting—or for any other lighting requirement where highline current cannot be used. They are of simple but rugged construction, and long-lived, even under the most severe working conditions. Their steam consumption is less than that of any other Turbo-Generators of equal size and capacity. Furnished in five types, with capacities ranging from 500 watts to 7½ K.W.

Write for Pyle-O-Lite Catalog No. 4.

The PYLE-NATIONAL COMPANY

1334-58 N. KOSTNER AVE., CHICAGO

General Offices and Works:
1334-58 N. Kostner Ave.
CHICAGO



In Canada:
The Holden Co., Ltd.
Montreal, Winnipeg,
Vancouver, Toronto

The Guardian of Countless Bearings

AFTER all, there is only one place where a lubricant is worth anything to you, and that is in your bearings. If it is Keystone Grease, it will stay in its proper place and lubricate, because of its unchanging density.

Keystone Grease is a pure petroleum product made in densities to suit various conditions. It is as honest a lubricant as can be made and safeguards countless thousands of bearings in America's leading industrial plants. THE KEYSTONE LUBRICATING CO., *Est. 1884,* PHILADELPHIA, PA., *at 21st & Clearfield Streets.*

KEYSTONE ACCOMPLISHMENTS

No. 1 of a series

"We are pleased to say that the Keystone Lubricating Greases that we have been using, especially No. 1 and 6 density, have proven very satisfactory to every test that we have put them.

"In our former experience of six years of using the ordinary greases and our experience in the past four years with the Keystone greases we have positively experienced that we are greatly benefited in every way as to waste, cleanliness and service and wear produced. One pound of Keystone Grease will go as far as three pounds of any common ordinary grease. With the care that we are taking of it we are today using one pound of grease, whereas it would take four pounds of ordinary grease.

"No one needs to fear the results of these greases, as they are reliable, substantial, uniform and well-proportioned greases."

Taken from a nationally known manufacturer's letter to Keystone.

Buying executives facing cost-reduction problems will find an exchange of ideas with a Keystone Sales Engineer profitable. Through our sales engineers, Keystone's forty years' experience in cutting lubrication costs is available.

To insure your seeing the Keystone representative when he calls, we would suggest that the executive responsible for specifying the lubricant to be used write us expressing his desire.

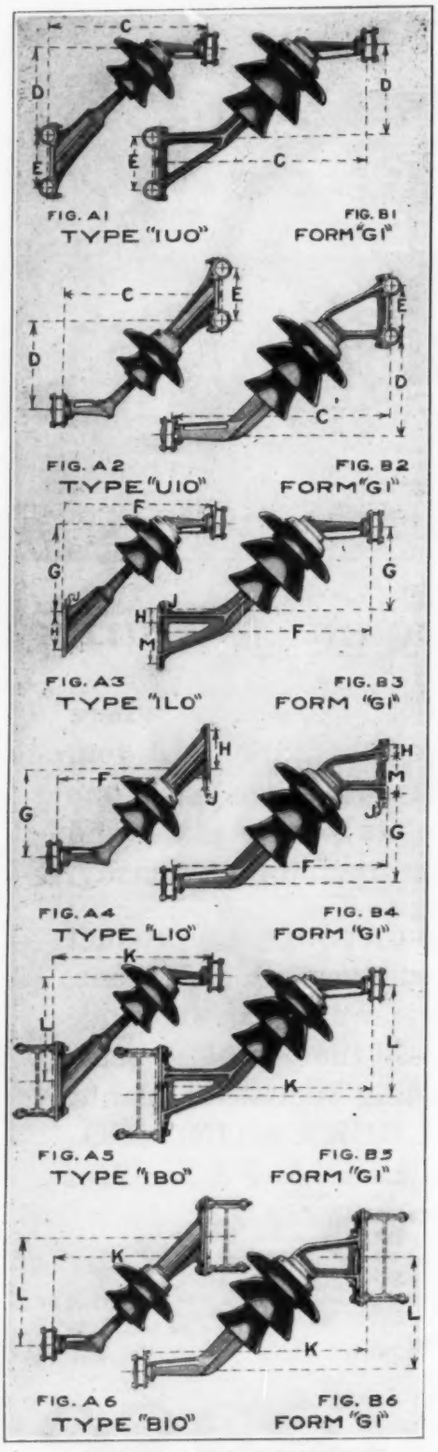
KEYSTONE GREASE

Keystone Grease

The Master Lubricant

For Every Industry

Reg. U. S. Pat. Off.



OUTDOOR BUS SUPPORTS

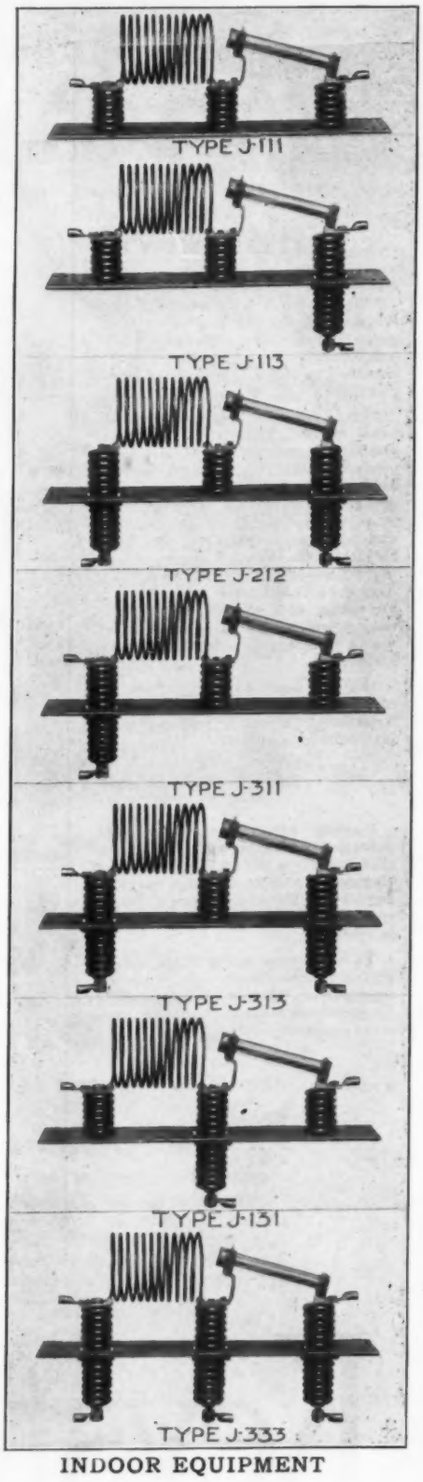
The Real Standard "UNIT TYPE"

DELTA-STAR

Indoor and Outdoor

HIGH TENSION EQUIPMENT

Ask for Bulletins



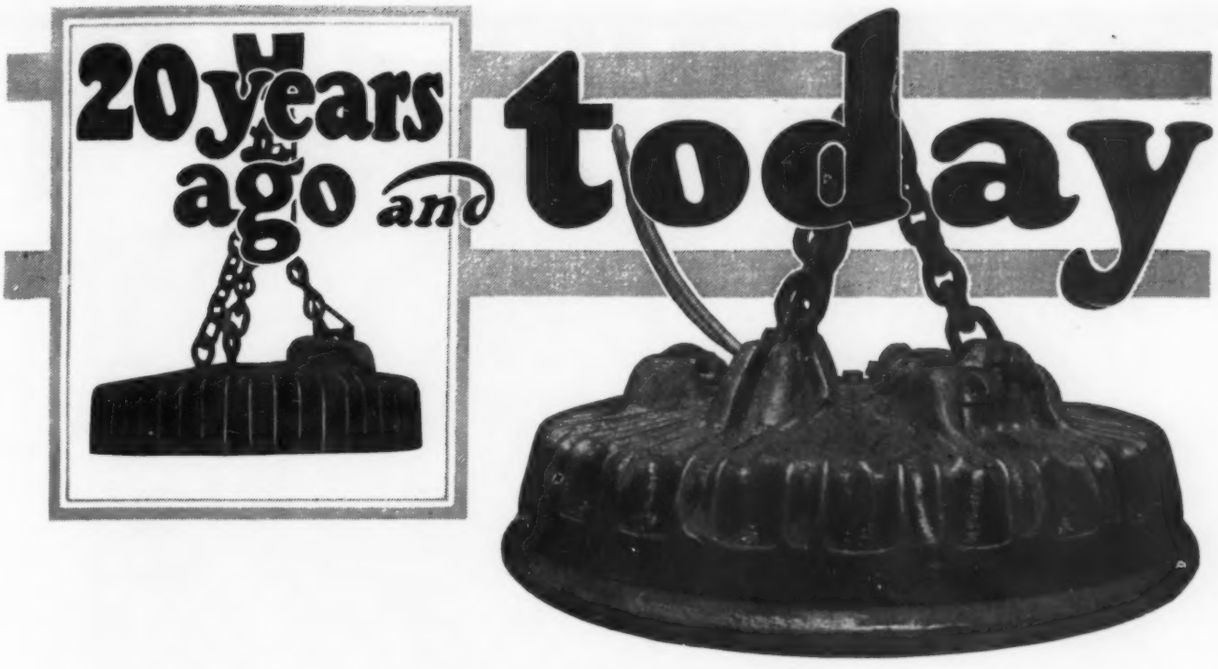
INDOOR EQUIPMENT

Delta-Star Electric Co

934 Union Trust Bldg.
Pittsburgh

1333 Real Estate Trust Bldg.,
Philadelphia

2433-61 Fulton St.,
Chicago



The NEW EC&M Lifting Magnet

The first commercial scrap handling Magnet was built by the E.C.&M. Co. twenty years ago.

The NEW Magnet shown above is the latest development in Magnet Construction.

Get in touch with nearest office given below for details.

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

BIRMINGHAM - BROWN-MARX BLDG.
CHICAGO - CONWAY BLDG.
CINCINNATI - 1ST NATIONAL BANK BLDG.
DENVER - 3535 WALNUT ST.
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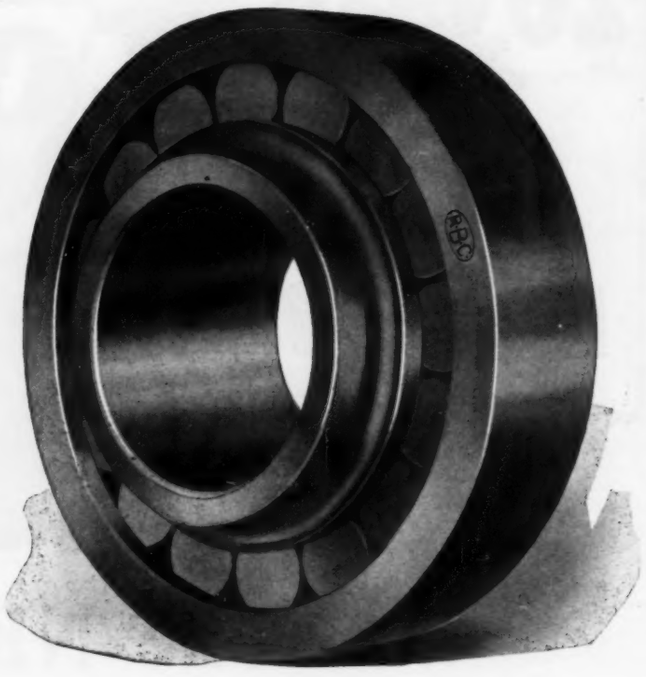
LOS ANGELES - O. E. THOMAS CO. AMERICAN BANK BLDG.
NEW YORK - 50 CHURCH ST.
PHILADELPHIA - WITHERSPOON BLDG.
PITTSBURGH - OLIVER BLDG.
SAN FRANCISCO - CALL BUILDING
SEATTLE - 524 1ST AVE. SOUTH
TORONTO - TRADERS BANK BLDG.

PRODUCTION
RECORDS
are never made with
General Purpose Tools
or Machines.



OBTAINING AND SUSTAINING
Record Production
Requires Highly Specialized Equipment

ROLLWAY
BEARINGS

Are the Specialized Bearing Equipment of Industry

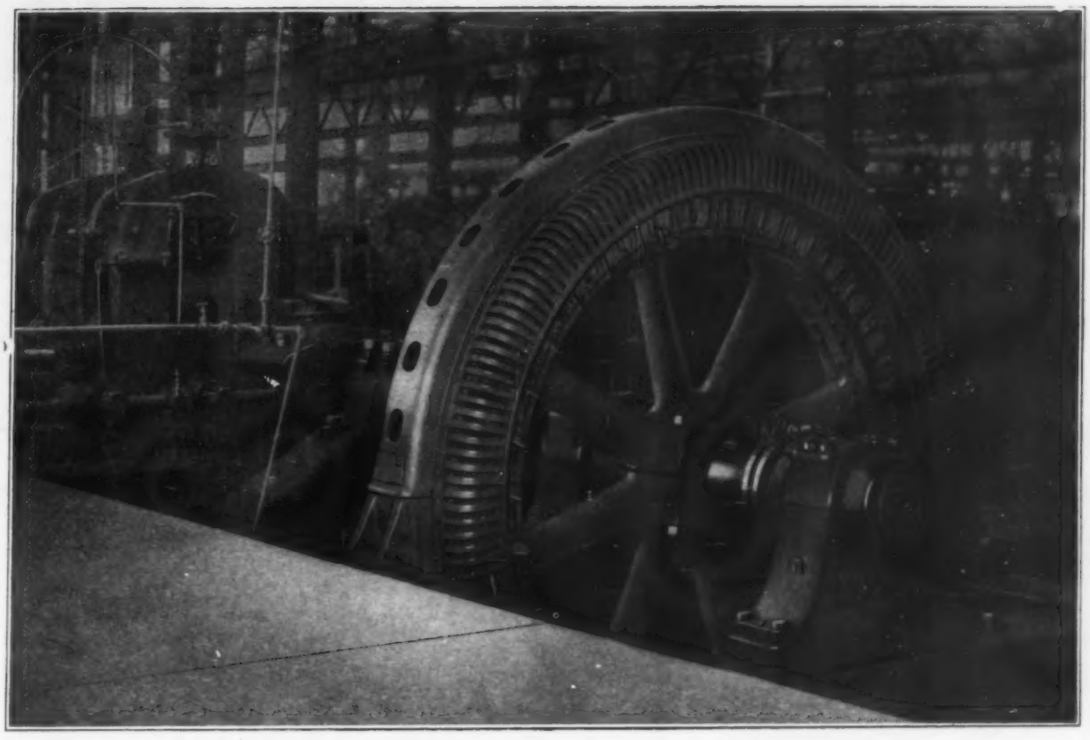
No compromises are permitted in Rollway design. Each Rollway unit is built to perform a definite function. Ample metal of the finest grade scientifically heat treated combined with precision workmanship ensures this.

As one user expressed it—"They've got the guts."

Detailed information for Rollway equipment for any type of motor used in steel mill service, old or new, on request.

Made in
SYRACUSE, NEW YORK, U. S. A.
by
ROLLWAY BEARING CO., Inc.

ALLIS-CHALMERS



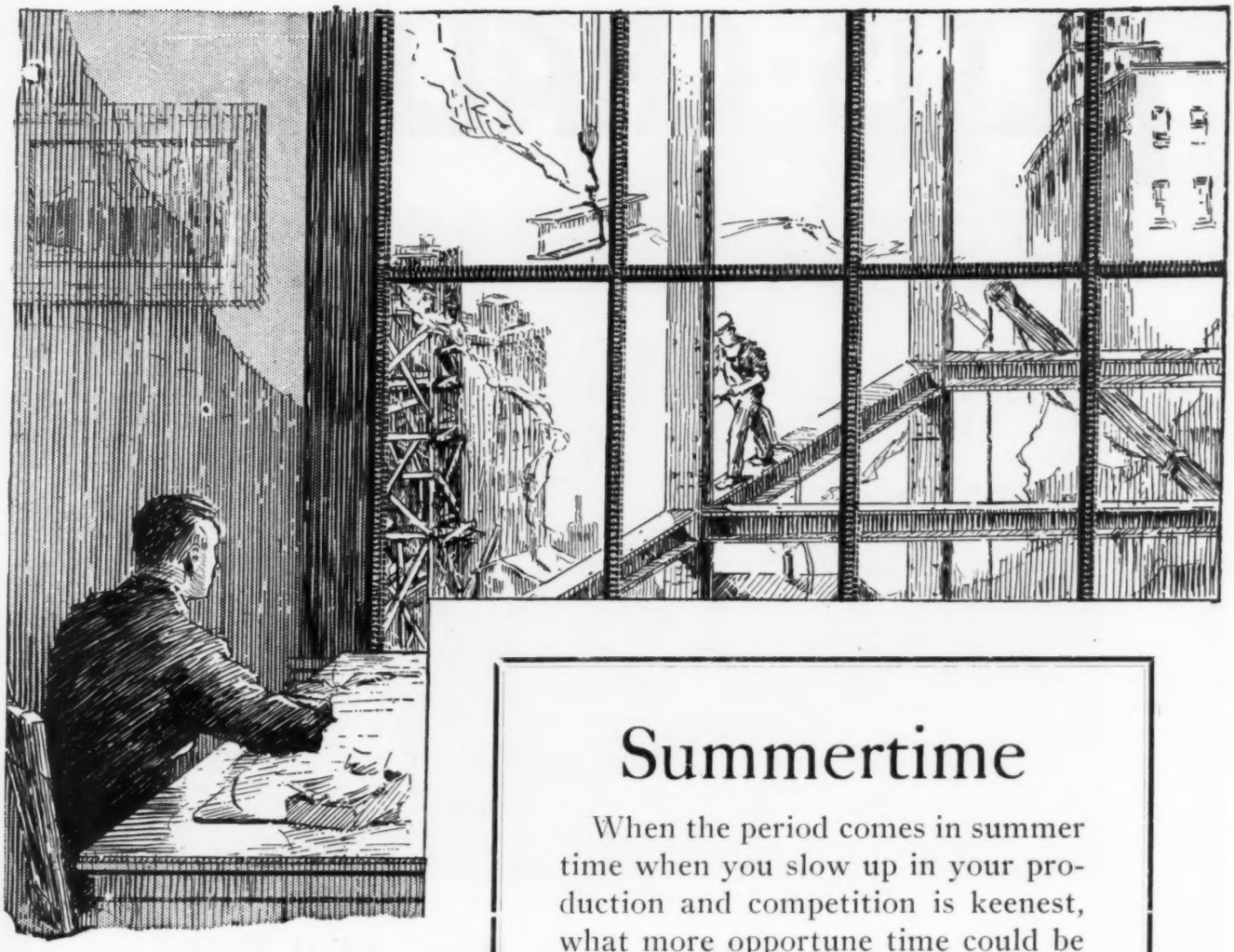
Synchronous Motor Rolling Mill Drive

800 H.P., 109 R.P.M., 2200 V., 3 Ph., 60 Cy., Mill Type Synchronous Motor, driving two stands of 21″ rolls. This Mill Type Synchronous Motor, coupled directly to the mill without the use of a clutch, has been entirely successful.

ALLIS-CHALMERS PRODUCTS
Electrical Machinery
Steam Turbines
Steam Engines
Gas and Oil Engines
Hydraulic Turbines
Crushing and Cement Machinery
Mining Machinery

ALLIS-CHALMERS MANUFACTURING COMPANY
MILWAUKEE, WISCONSIN. U.S.A.
District Offices in All Leading Cities

ALLIS-CHALMERS PRODUCTS
Flour and Saw Mill Machinery
Power Transmission Machinery
Pumping Engines-Centrifugal Pumps
Steam and Electric Hoists
Air Compressors - Air Brakes
Agricultural Machinery
Condensers



Summertime

When the period comes in summer time when you slow up in your production and competition is keenest, what more opportune time could be had to have a study made of your power costs?

Duquesne Light service will reduce your production costs, thus giving you a better basis for success in competitive markets.

Duquesne Light service will also enable you to operate your plant more efficiently at reduced capacity, eliminating much overhead thereby.

Let us send a power representative to discuss your power problems. His services are free.

Commercial Department
Duquesne Light Company

Two P & H high speed 105-foot span cranes with 15-foot cantilever at each end owned by the C. B. & Q. R. R., located at Eola, Illinois.

23 Minutes Per Car

The speed with which scrap is handled by the immense P & H Cranes at Eola not only expedites the cleaning up and reclamation, but has effected unusual economies.

This fast service permits of unloading and releasing cars quickly for revenue producing work, the sorting and reclaiming being done between unloadings.

A recent check on performance showed a total of only 5 hours required for the unloading or 13 cars of scrap iron —23 minutes per car.

If you have any material handling job, a P & H Crane will insure low maintenance cost, speed (if speed is essential), and dependability. The 40 years of P & H and the most complete crane manufacturing plant in the world are at your disposal.

THE working range of these immense P & H Gantry Cranes is 135 feet wide. The crane runway is 1604 feet long—the bridge speed, 300 feet per minute. Each crane has a capacity of 15 tons with 5 ton auxiliary.

More than 7,300 Cranes in service. Below is partial list of users:

Allis-Chalmers Mfg. Co.
Bethlehem Steel Co.
American Brass Co.
Baldwin Locomotive Works
International Harvester Co.
American Locomotive Co.
Ford Motor Co.
Ingersoll-Rand Co.
Worthington Pump & Mach. Corp.
Chicago & Northwestern R. R.
Warner Sugar Refining Co.
Dodge Bros.
Fairbanks, Morse & Co.
Westinghouse Mach. Co.
National Carbon Co.
Calumet & Hecla Mining Co.
Studebaker Corporation
Bullard Machine Tool Company
Crane Company
New Jersey Zinc Company
Simmons Co.
Standard Oil Co.
Jeffrey Manufacturing Co.
Firestone Tire & Rubber Co.
Gisholt Mach. Co.
Chain Belt Co.
Busch-Sulzer Diesel Eng. Co.
Weyerhaeuser Timber Corp.
Nordyke & Marmon Co.

Crane and Hoist Division

PAWLING & HARNISCHFEGER CO.

Established in 1884

3855 National Avenue, Milwaukee, Wis.

New York
Atlanta
Detroit
Kansas City
Chicago
Portland
Memphis
Dallas
Seattle
Philadelphia
Pittsburgh
Los Angeles
San Francisco

P&H CRANES and HOISTS

HOFFMANN PRECISION ROLLER BEARINGS

For Heavy Loads and Hard Service

Heavy-duty units manufactured to unequaled standards of precision; affording the maximum of serviceability under conditions involving heavy loads, temporary overloads, shock, jar and vibration; offering to manufacturers and users of electrical machinery for the steel plant new opportunities for power saving, reduced upkeep costs, and better service.

Our engineers will welcome an opportunity to work with yours, in applying these high-duty, high-precision bearings to your machines, with a view to securing maximum anti-friction efficiency, minimum maintenance costs, and continuity of service.

THE NORMA COMPANY OF AMERICA
Anable Avenue
Long Island City New York
MAKERS OF "NORMA" PRECISION BALL BEARINGS

ALL SPEEDS and POWERS

STANDARD and SELF-ALIGNING TYPES

ECONOMY *renewable* FUSES

INDUSTRIES using electrical energy save 80% annually in fuse maintenance costs when they install Economy renewable Fuses in the place of "one-time" fuse-equipment.

Economy Fuse performance is a matter of record—they were the first fuses using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be *Approved in All Capacities* by the Underwriters' Laboratories.

Economy "Drop-Out" Renewal Links cost but little and make the restoration of a blown fuse the work of a moment only.

Your plant needs Economy Fuses. Investigate the quality of the electrical protection you now have from the standpoint of dependability, efficiency and economy.

Then order Economy Fuses installed.

For Sale by all leading Electrical Jobbers and Dealers.

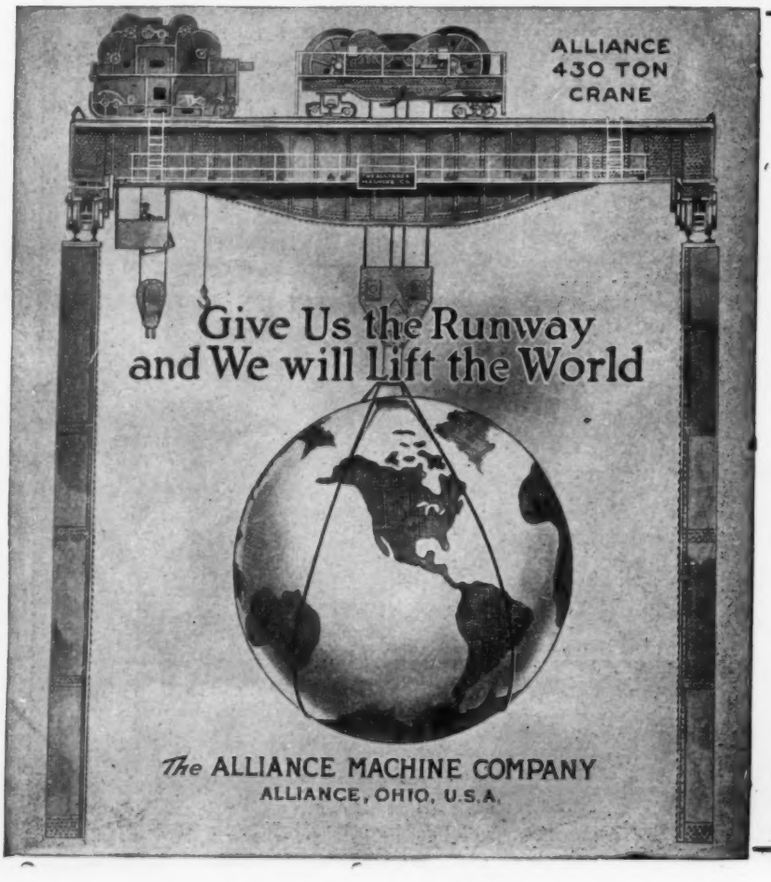
ECONOMY FUSE & MFG. CO., Chicago, U. S. A.

Economy Fuses are also made in Canada at Montreal

Pittsburgh Transformer Company

Largest Manufacturers of Transformers Exclusively in the United States

Pittsburgh, Pennsylvania



ALLIANCE CRANES

Largest Builders of the World's Largest Cranes

204 of 100 Tons Capacity and Over

STANDARD CRANES

55		100 tons
2		115 tons
42		125 tons
24		150 tons
22		175 tons
2		200 tons
1		225 tons
1		250 tons
3		430 tons

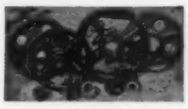
STRIPPING CRANES

8		100 tons
1		125 tons
19		150 tons
13		200 tons
1	Single Ram,	320 tons

COMBINATION CHARGERS AND STRIPPERS

3		100 tons
3		150 tons
4		200 tons

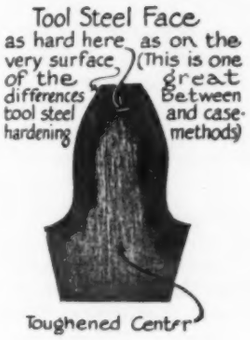
Herringbone Mill Pinions



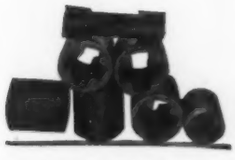
Motor and Crane Gears

Mill Table Gears

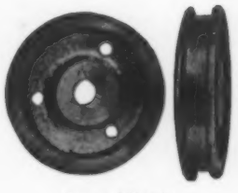
Herringbone Gears


Tool Steel Face
as hard here as on the very surface (This is one of the great differences between tool steel and case-hardening methods)
Toughened Center

Cincinnati "Tool Steel" gears outlast 8 to 10 Untreated and are much stronger



Coupling Boxes and Spindles



Crane Wheels

The Tool Steel Gear and Pinion Company
CINCINNATI, OHIO

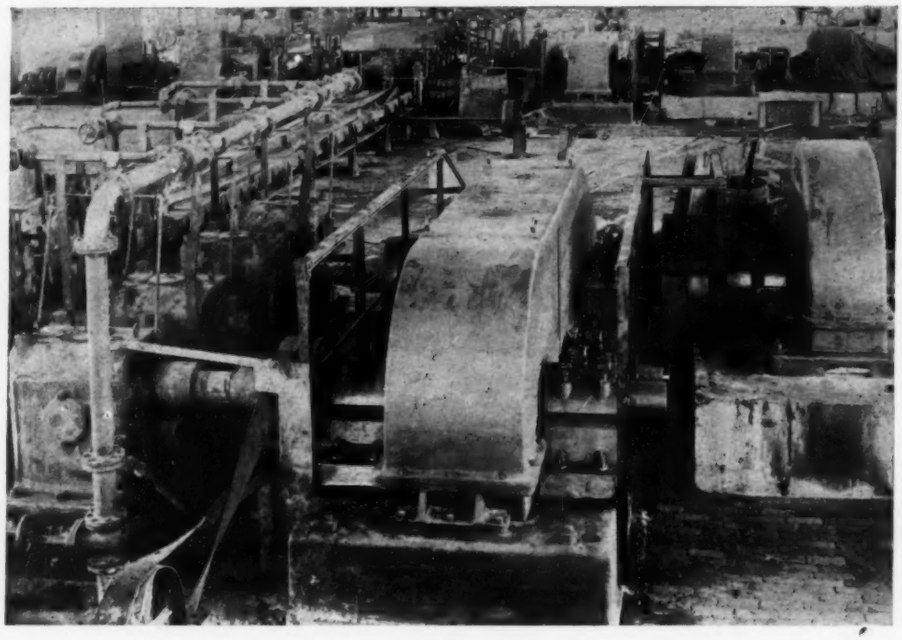
There is a

HOLOPHANE LIGHTING UNIT

for Your Every Need

The Unit illustrated is especially recommended for industrial plants

RUMSEY
ELECTRIC COMPANY
Electric Supplies and Machinery
Everything in Radio
1007 Arch St.
Philadelphia, Pa.



This illustration shows the installation of drives in the plant of Conners Steel Company, Birmingham, Ala., and are for transmitting power from 700 horsepower motors, 870 r.p.m. through standard single reduction herringbone gear drives and special four speed herringbone gear drives to four stands each of roughing and strand rolls of a continuous strip mill, obtaining mill speeds on the roughing mills of 55 to 207 r.p.m., and on the strand mills 66 to 247 r.p.m.

Fawcus Herringbone Gear Drives for Greater Power, Reduction, Speed, Silence, Efficiency, Durability

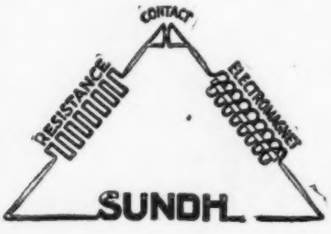
Cut Herringbone Gears, Spurs, Bevels, Worms and Flexible Couplings, Special Machinery

FAWCUS MACHINE COMPANY, Pittsburgh, Pa.

NEW YORK, N. Y., Robt. C. Brown, 84 Pine St.
MILWAUKEE, Wis., L. E. Meidinger
PORTLAND, Ore., Coast Steel Machinery Co.

REPRESENTATIVES:
SAN FRANCISCO, Calif., K. W. Eichelberger

BIRMINGHAM, Ala., G. R. Mueller Co.
CHICAGO, Ill., Hodgart & Co.
NEW ORLEANS, Southern Jobbers Supply Co.



Steel Men!

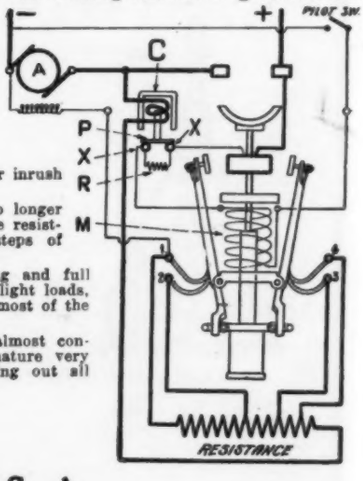
Isn't this what some of you wanted, as brought out in your discussion of control in your Journal of November, 1921? A control that would have definite time limit modified with current limiting element?

You want a starter to obey its real function, don't you? i. e., to start and accelerate a motor by cutting in resistance, then out, in the shortest possible time in relation to the load. You want the motor to "mote" if it's at all possible to do so, whether the voltage is high or low, or whether there is excessive friction on a cold Monday morning. If the first current inrush does not start it, the next one may. If we can't get it to start on small amounts of current, we want to provide automatic means of increasing the current or power so that it will start, provided that no one has placed a crowbar in between the gears or there happens to be a short circuit. In that case, overload circuit opening devices take care of the condition.

We have been using this method since 1911. On large size motor starters, reversing and non-reversing, we use the multiple level starter as a pilot relay whose multi-contact energizes large shunt wound switches for cutting out starting resistance.

The action of this control is easily understood from the diagram, and the following description of operation:

The relay C is in series with the armature only during the starting period and is normally set to operate at about 130% of normal current. When the current in the armature of the motor equals or exceeds this setting on the starting inrushes, the armature of the relay lifts the plate P from the two contacts XX and by this action inserts the resistance R in series with the solenoid coil M of the automatic starter. The resistance R can be made to have a resistance so that when inserted in the circuit of the coil M (by action of excess load on the armature of motor at start) it partly destroys the effective magnetic pull of coil M and prevents the cutting out of any more resistance in the armature circuit, but at the same time there is sufficient magnetic pull to lift the core very slowly so that in time, even with the insertion of this resistance in the magnet coil circuit, the next succeeding step of resistance will be cut out, giving a larger inrush current to the motor.



Under normal conditions as soon as the current in the armature reduces to about normal, the coil C can no longer hold up plate P and it consequently drops, thus closing the circuit across contacts XX, and short circuiting the resistance R, allowing coil M to be again fully energized and to act with full power, thus cutting out succeeding steps of resistance quickly.

The retarding action caused by excess load on coil M may take place during any interval between starting and full running position. The time of the dash pot is generally set for a minimum of 1½ seconds, which in case of very light loads, the cutting out of resistance would take approximately this time, since the series relay coil C plate XX, would be most of the time short circuiting the resistance R.

Under abnormal, extremely heavy loads, where the series coil C would lift its armature and hold it up almost continuously, thus inserting all the resistance in the coil, R circuit on automatic starter coil M would lift its armature very slowly against the action of the dash pot and light pulling force, and may take up to 15 seconds before cutting out all resistance.

The resistance R may be made of a value as to either increase or decrease the pull of magnet coil M.

Write for Catalog.

SUNDH ELECTRIC COMPANY Newark, N. J., U. S. A.

SAND—

is the only Cure for

SLIPPERY CRANE RUNWAYS

"It Takes Sand To Win"

Do you allow your men to pour it on with a bucket?——

Or do you allow your cranes to be operated on slippery runways?

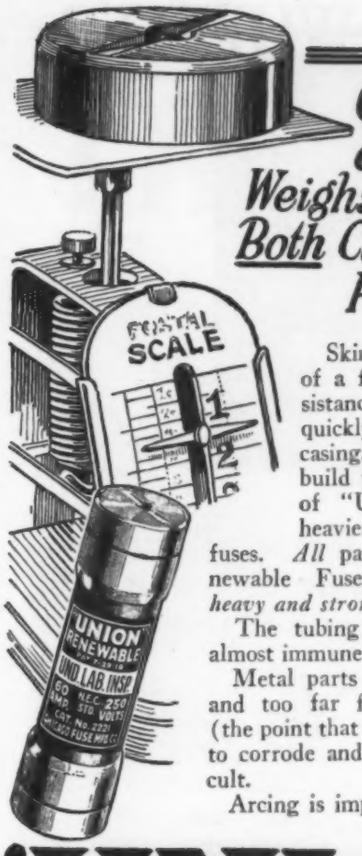
Both methods endanger your cranes, the lives of your operators and the men on the floor.—This also means unnecessary delays and losses.

Apply sand at the right time, the right place and in the proper amount by equipping your cranes with Lintern Electro Magnetic Sanders.

A number of plants are now in the process of equipping all of their cranes with Sanders. They will secure efficient and economical operation with all hazards due to slippery rails eliminated.

The
NICHOLS-LINTERN COMPANY

7960 Lorain Avenue Cleveland, Ohio



One Cap on a "UNION" Weighs More than Both Caps on Many Fuses

Skimping on brass parts of a fuse increases the resistance, creates heat and quickly burns out the fibre casing. That's why we build the caps and ferrules of "Union" Fuses much heavier than those of most fuses. *All* parts of "Union" Renewable Fuses are *exceptionally heavy and strong.*

The tubing is extra thick and almost immune to fire.

Metal parts are specially treated and too far from center of link (the point that melts when it blows) to corrode and make renewal difficult.

Arcing is impossible. also. in

'UNION'
RENEWABLE FUSES

The link blows without flash or violence. But as an added precaution, the large fuses are provided with safety valves to further reduce the violence of blow-outs.

All these factors mean SERVICE—longer life—a greater number of blow-outs taken care of. These features, together with ease of renewal are the reasons why

The "Union" saves more than ANY other renewable fuse

The Underwriters Laboratories naturally give the highest endorsement to "Union" Fuses, both Renewable and Non-Renewable. Sold by electrical jobbers and dealers.

Write for our new 96-page catalog

Chicago Fuse Mfg. Co.

Manufacturers also of Switch and Outlet Boxes, Cut-Out Bases, Fuse Plugs, Fuse Wire and Automobile Fuses.

CHICAGO NEW YORK

CROCKER-WHEELER

"The name of Ampere will survive in books, but owing to you it will survive in another way."

"It will survive on the map of the country in which we live and on the map of the United States. You have inscribed it in a ground which is holy to us—to which every Frenchman has a feeling of respect—a sympathy which has been proved in that early struggle by the forces of France and America. The name of Ampere shall last forever. As a Frenchman, as a compatriot, I wish prosperity and happiness to Ampere."

From an address by Jules J. Jusserand, French Ambassador to the United States, December 3, 1908, at the unveiling of the above tablet, erected to the memory of the great French scientist, André Marie Ampere, by The Crocker-Wheeler Company, Ampere, N. J.

CROCKER - WHEELER COMPANY
AMPERE NEW JERSEY

Pioneer Motor Manufacturers—Established 1888

BALTIMORE	CHICAGO	NEW YORK
BIRMINGHAM	CLEVELAND	PHILADELPHIA
BOSTON	DETROIT	PITTSBURGH
BUFFALO	NEW HAVEN	SAN FRANCISCO

Foreign Distributor: International Western Electric Co.

CROCKER-WHEELER COMPANY TRADE MARK

MOTORS & GENERATORS

1891 — 1924

MORGAN
Construction Company

Worcester, Mass., U.S.A.

Designers and Builders of

Morgan Continuous Mills

for

Billets, Sheet Bars, Skelp, Merchant-Bars, Hot-Strip, Rods

also

Wire Drawing Machines
Producer Gas Machines
Straightening Machines
Isley Reversing Valves
Re-Heating Furnaces
Reducing Gear Units
Shears

Our Engineering Department

is prepared to solve successfully your problems in design or arrangement of plant and equipment from open hearth to finished product

1891 — 1924

Electrical Engineering and Manufacturing Company

General Offices:

PITTSBURGH, PA.

We are prepared to furnish your requirements in the following materials and equipment:

"MORGANITE" Carbon-Graphite Metal Brushes.

"ROWAN" Automatic Controllers and Starters.

"SUMET" Bronze and Babbitt Bearing Metals.

"DUTCHESS", Empire or Varnished Cloth and Tape.

"SCHENECTADY" Electrical Insulating Varnishes and Compounds.

"BELL" Cedar Poles.

CROSSARMS: Douglas Fir and Pine.

LINE MATERIALS: Hangers, Brackets, etc.

TRACK GRINDERS: Reciprocating, Rotating, and Swing Frame.

"AJAX" Resistance Type Welding and Bonding Machines.

"LITEWELD" Electric Arc Welder—Dynamotor Type.

RAILWAY and Mine Bonds.

MINE HOISTS and Winches, Car Pullers, etc.

HIGH and **LOW** Tension Insulators.

"ELPECO" High and Low Tension Switching Equipment, Bus Fittings, etc.

"BENNETT" Lightning Arrestors.

We have a corps of expert engineers, specialists in the above lines, who will be glad to give immediate attention to your inquiries or to see you at your request for consultation regarding applications or equipment. Call or write our nearest office.

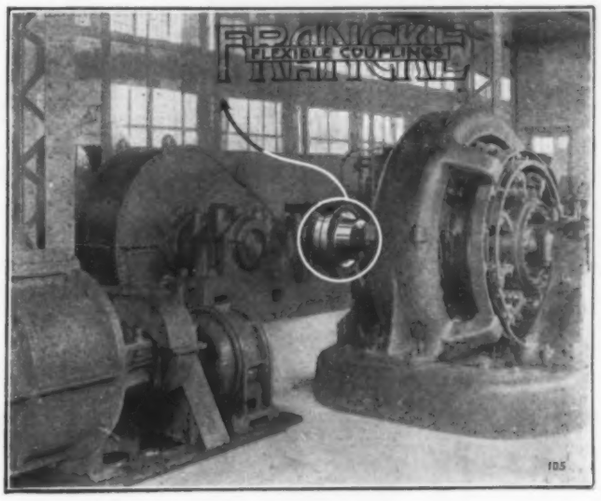
CINCINNATI, OHIO
607 Mercantile Lib. Bldg.
Phone Maine 3257

CLEVELAND, OHIO
320 Union Bldg.
Phone Prospect 1252

PITTSBURGH, PA.
907-909 Penn Ave.
Phone Grant 6693-4

FRANCKE
FLEXIBLE COUPLINGS

"They make good machines last longer"



Francke flexible couplings save needless installing and operating-trouble costs. They are flexible in all directions. They are all-metal and durable. And in addition they provide a spring cushion for load shocks, vibrations, etc.

As with any coupling the shafts should be lined up accurately when installed. With a Francke this is quite easy. Simply use a straight edge across the flanges at three points each about 90 degrees apart, and also measure the spacing between flanges at similar points.

To take care of all of the conditions usual with the many kinds of direct drives there are five different types of Francke flexible couplings—sizes to transmit from ¼ H.P. to 8,700 H.P. Depending upon operating conditions some of these should be lubricated, but in most cases a Francke needs no attention after it is installed.

By removing the strains otherwise resulting from misalignment and by providing a spring cushion for shocks, Francke flexible couplings make good machines last longer.

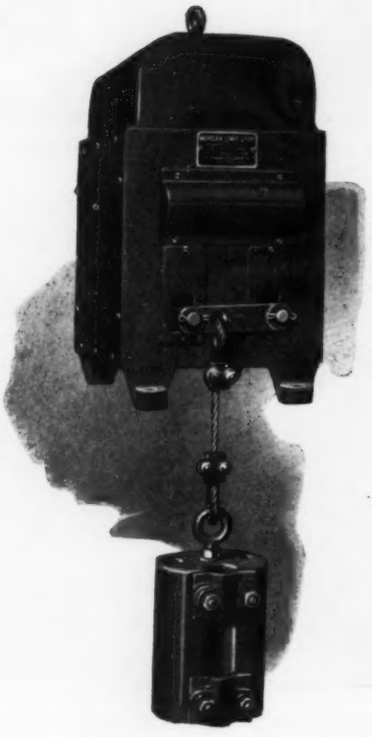
Write for Bulletin No. 37.

SMITH & SERRELL

Coupling Specialists Since 1912.

64 Washington Street, Newark, N. J.

District Office, Fulton Building, Pittsburgh



Morgan Safety Limit Stop

WACKERLY TYPE

For All Types of Direct Current Motors

A FEW OF THE ADVANTAGES

No heavy current broken by contactors.

Limit Stop can be connected up with any standard make of controller.

No extra conductors required.

Normal lowering circuits established immediately upon reversal of controller. No waiting to lower through resistance.

No external banks of resistance. Limit Stop is self contained.

Only one swinging weight used, this being guided by one of the hoisting ropes.

Positive in action. A movement upward of weight of a fraction of an inch will actuate limit stop.

Occupies minimum floor space on trolley.

Sequence of operation of contactors obtained by simple system of levers. No cams, springs or counterweights used.

For full particulars on this stop send for Bulletin No. 29.

The Morgan Engineering Co.

Alliance, Ohio

CHICAGO
122 So. Michigan Ave.

NEW YORK
120 Broadway

PITTSBURGH
1420 Oliver Bldg.

LAPP HIGH VOLTAGE PORCELAIN

Did you ever hear of a failure of a Lapp Insulator?

Seven years of production—including highest voltage pin and suspension types —without a failure!

There is the reason for use of Lapp Insulators, besides which—for "trimmings" —they provide unexcelled mechanical strength.

Lapp vacuum process of porcelain production, surfaces of porcelain glazed all over, Lapp over potential test methods.

LAPP INSULATOR CO., Inc., LeRoy, N. Y.

S. H. LANYON
509 New Call Bldg., San Francisco

O. H. Davidson Equipment Co.
1633 Tremont St., Denver

Commercial Electrical Supply Co.
Broadway and Spruce St., St. Louis

J. E. Sumpter Co.
940 Security Bldg., Minneapolis

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Robertson-Cataract Electric Co.
Buffalo

J. W. Fraser & Co.
Charlotte, N. C.

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W. D. Hamer Co.
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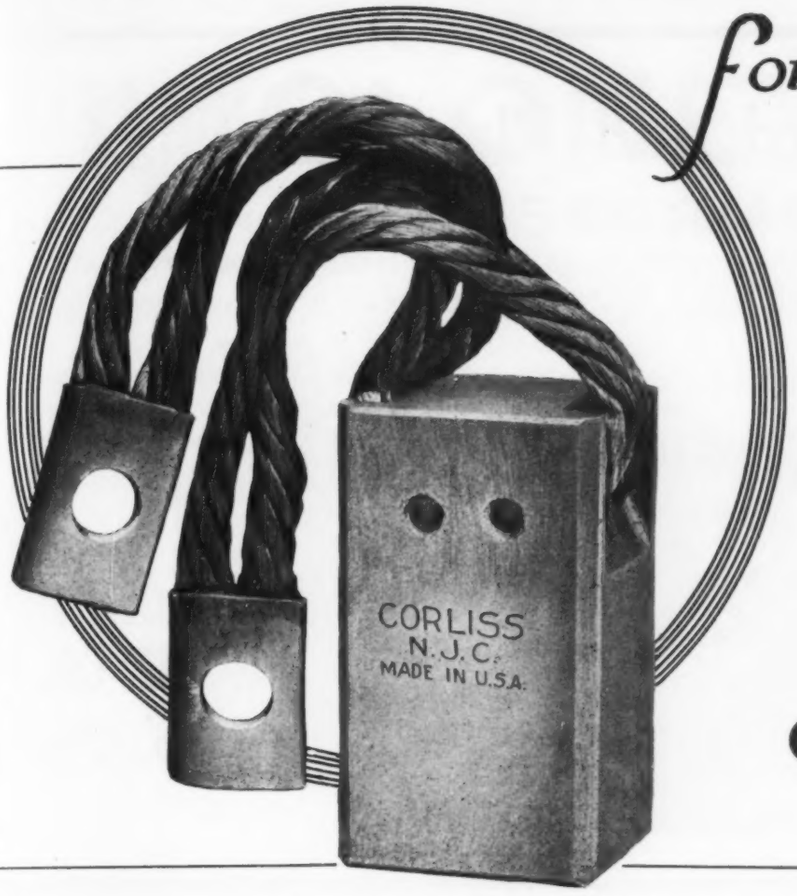
Wellington, New Zealand



For Rotary Rings
N. J. C.

gives maximum life with minimum dusting and ring wear.

Current densities up to 150 Amperes per sq. in.

CORLISS CARBON CO.
BRADFORD, PA.

E 96.4

W. E. finish Salamander magnet wire is particularly adapted for rewinding field and armature coils, solenoids, etc., and is used extensively in the steel industry. It is acid-proof, moisture-proof, oil-proof, heat-resisting and has an extremely tough, smooth, hard finish.

For further information write to our nearest representative for Salamander wires and cables—

Birmingham, Ala.	W. H. Beaven
Boston, Mass.	Wetmore-Savage Company, 74 Pearl Street
Chicago, Ill.	J. D. A. Cross, 213 S. Peoria Street
Cleveland, Ohio	H. Lee Reynolds Company, 309 Plymouth Building
Denver, Colo.	Franklin Sales Company, Denham Building.
Los Angeles, Cal.	A. S. Lindstrom, 1144 Maple Avenue
Philadelphia, Pa.	F. K. Simons Electric Co., Fuller Building
Pittsburgh, Pa.	H. Lee Reynolds Company, Oliver Building.
Portland, Ore.	A. S. Lindstrom, 312 McKay Building
Salt Lake City, Utah	Raymond Ackerman, 419 Dooly Building
San Francisco, Cal.	A. S. Lindstrom, 111 New Montgomery Street
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YORK INSULATED WIRE WORKS
of General Electric Company

Works: York, Pa. Office: 1737 Broadway, N. Y. C.

Better Yard and Plant Hauling

Ironton Storage Battery Locomotives meet perfectly the hauling conditions in the yards and plants of many steel mills. Dependability, low power cost, simplicity—are its big advantages. Irontons operate 24 hours a day.

Let Ironton engineers study your conditions and make you a guaranty of Ironton Performance under your conditions.

The IRONTON ENGINE CO.
Ironton, Ohio

5 Reasons Why USG Brushes are Extraordinary Brushes

1. Because the graphite used in their make-up all comes from our own mines in Mexico.
2. Because every step in the manufacturing process, from mining the ore to the finished brush, is done by our company.
3. Because our engineers are Brush Experts who have devoted their lives to the perfection and manufacture of better brushes.
4. Because each order is considered separately and the individual requirements of the machine taken into consideration before the grade recommendation is made.
5. Because of the feeling of ease and security which follows the application of U. S. G. Brushes.

Write for the list and characteristics of all grades of U. S. G. Brushes.

USG

on every brush

THE UNITED STATES GRAPHITE COMPANY
Saginaw, Michigan, U. S. A.

MOLONEY
TRANSFORMERS

WE have been manufacturing transformers now for over a quarter of a century—a long time in an industry so young.

Moloney Engineering Experience has dealt with the transformer in every phase of its development.

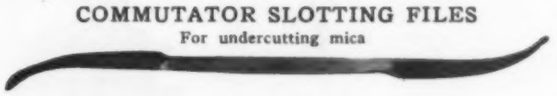
From the first, Moloney Engineers have been animated by a two-fold purpose: to build the highest attainable quality, and to build it economically.

Moloney Transformers are recognized by all transformer users as the highest standard—a fact which demonstrates the success which has crowned the efforts of Moloney Engineers.

MOLONEY ELECTRIC CO.
Manufacturers of Transformers Exclusively
FACTORY AND MAIN OFFICE
St. Louis, Mo.
Offices in All Principal Cities

Use "Imperial" Commutator Stones

COMMUTATOR SLOTTING FILES
For undercutting mica



GOODNITE CLEANING TOOL
For cleaning Commutator slots

REASON NO. 5. They save from 80% to 99% of the time required to remove an armature and turn the commutator in a lathe. Write for Bulletin.

Advantage No. 6 will be given next month. 2764 users on June 1st, a gain of 136 for May.

Send the Coupon for Complete Information

We can supply you with

Commutator Grinders	Insulating Beads
Slotting Files	Insulating Varnish
Slotting Machines	Gauze Wire Brushes
Commutator Cement	Portable Blowers

THE MARTINDALE ELECTRIC CO.,
11729 Detroit Ave., Cleveland, Ohio.

Gentlemen: Please send me information about your products.

Name and Title.....
(Please print)

Company .....

Street .....

City and State .....

Are You Wiring Wise?

There is always more than one way to do a thing, but, in most cases, there is one best way, and in electrical wiring that one best way is the **Unilet** way.

When **Unilets** are used, every wiring installation will be neatly and quickly completed, even though it is entrusted to inexperienced assistants, because of the scientific design, careful construction and absolute uniformity of the **Unilet** line.

Drawn from Cold Steel

Unilets are drawn and pressed from cold steel. All joints are electrically welded and ground until they are as smooth and rigid as the parent metal. This provides maximum strength with minimum weight, smooth surfaces, true dimensions, and greater wiring spaces without any increase in the size of the fittings —features that every electrician will recognize as essential to rapid work and neat jobs.

Unilet Bodies
Pressed cold from single pieces of high grade steel —a special design for every wiring requirement.

A Unilet for Every Wiring Need

Appleton engineers have worked and studied with practical wiring men for many years and have designed a Unilet to meet every conceivable situation. They are all listed in Appleton Catalog Nine and a pictorial index to the book makes it easy to find the fitting you want to solve each particular problem as it arises even though you don't know what to call it.

The "GS" Series
Designed to provide a steam, gas, dust and water proof enclosure for snap switches.

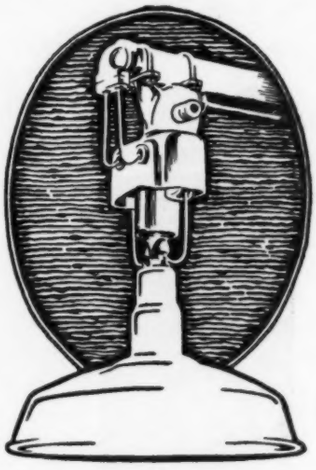
Write for Catalogue Nine.

APPLETON ELECTRIC COMPANY
General Offices and Factory
1717 Wellington Avenue
CHICAGO

APPLETON UNILETS
REG. U.S. PAT. OFF.

STANDARD FOR BETTER WIRING

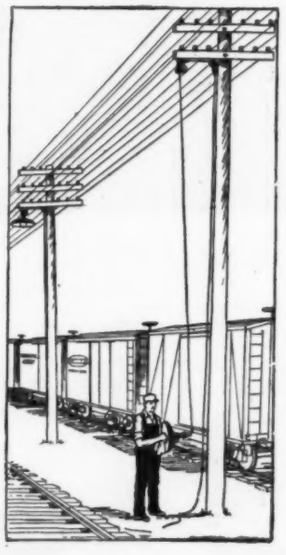
THOMPSON
Safety LOWERING Switch
or Disconnecting Hanger
"Teco" Underslung Model



makes
Lamp Maintenance
Accessible
with
Ease and Safety
for both indoor and outdoor use—easily included in present lighting systems.

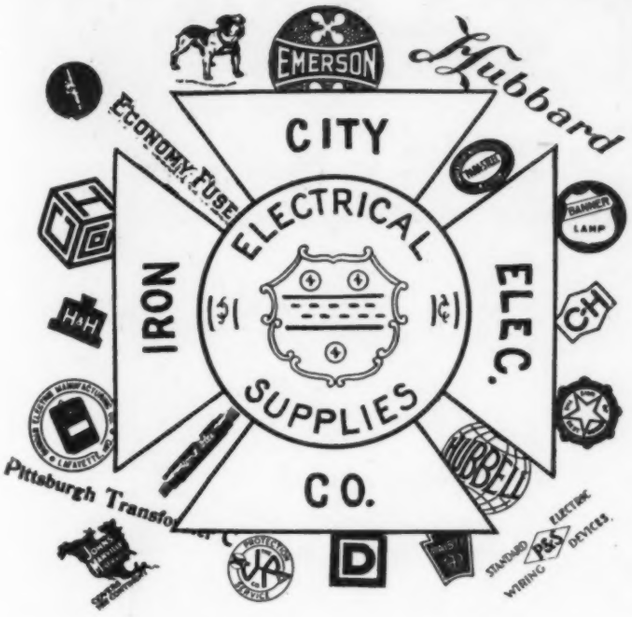
Get Catalog B-22

Safe



Logical

The Thompson Electric Co.
226 St. Clair Avenue, N. E.
Cleveland, Ohio, U. S. A.



The Trade Mark

of the

Iron City Electric Co.

436-38 Seventh Avenue

Pittsburgh, Pa.

REPRESENTING

"The House That Service Built"

IS BACKED BY A GROUP OF

TRADE MARKS

of Well Known Manufacturers Guaranteeing the Quality of the Goods You Receive

Umlambo

Before a Kaffir drinks from a pool he carefully peers into its clear depths to see if *umlambo* is lying in wait for him.

Umla··bo being the evil spirit that snatches unwary drinkers, hauls them down and changes them into fish.

It's a commendable practice to *look* into things before you *get* into them.

Of course you can't look into a carbon brush, because it's too dense — therefore greater chance for *Umlambo* to hide.

But you can get a look in on proper brush practice through engineering prescription.

That's the only way Morganite brushes are sold.

They enable you to drink deep of good commutation.

MORGANITE BRUSH CO., INC.
519 West 38th St., New York City
DISTRICT ENGINEERS AND AGENTS

Morganite

Electric Power Equipment Corp., 412-420 North 18th St., Philadelphia, Pa.

O. T. Hall, Sales Engineer, 1926 Edmonson Ave., Baltimore, Md.

Electrical Engineering & Mfg. Co., 909 Penn Ave., Pittsburgh, Pa.

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Special Service Sales Co., 502 Delta Bldg., Los Angeles, Calif.

J. F. Drummey, 75 Pleasant St., Revere, Mass.

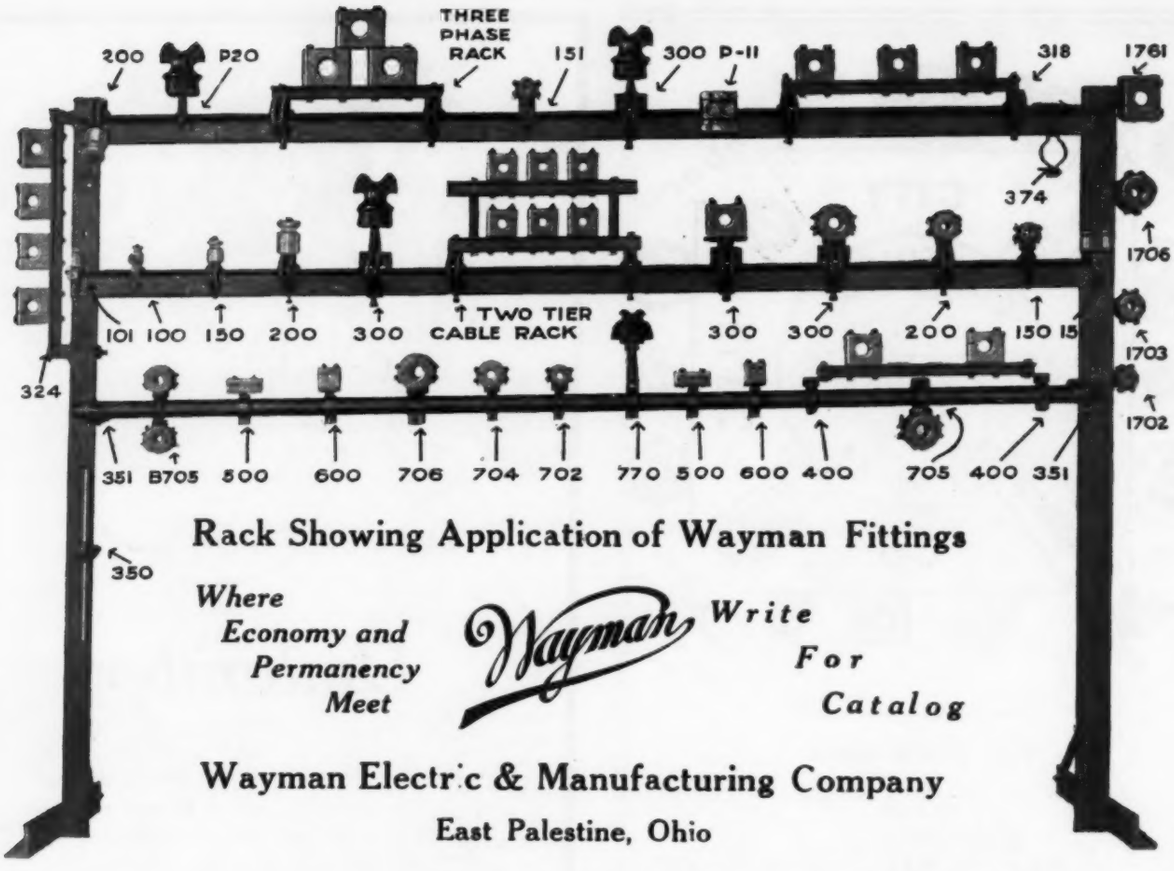
Special Service Sales Co., 202 Russ Bldg., San Francisco, Calif.

Electrical Engineering & Mfg. Co., 607 Mercantile Library Bldg., Cincinnati, Ohio.

Railway & Power Engineering Corp., Ltd., 131 Eastern Ave., Toronto, Ontario, Canada.

Railway & Power Engineering Corp., Ltd., 326 Craig St., West, Montreal, Canada

Railway & Power Engineering Corp., Ltd., P. O. Box No. 325, Winnipeg, Canada

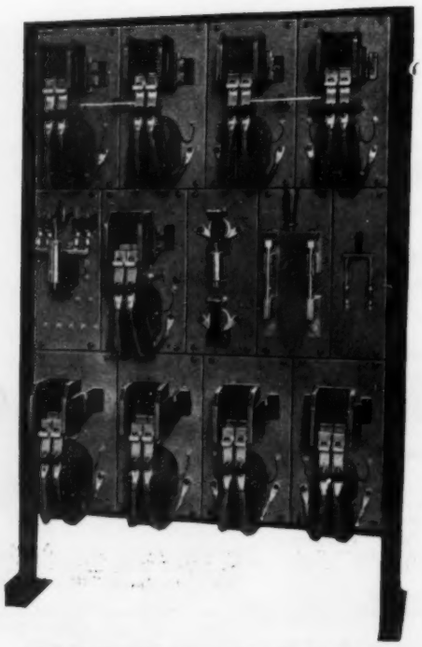


Rack Showing Application of Wayman Fittings

Where Economy and Permanency Meet Wayman *Write For Catalog*

Wayman Electric & Manufacturing Company

East Palestine, Ohio



150 H.P. Type 4750 Full Speed Reversing Mill Controller

Automatic Motor Starters and Controllers

for

Alternating and Direct Current Electric Motors

May we send our nearest representative to see you?

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

One-man "express" service

"Express" service throughout the plant is afforded with the Shepard "Aerial Railway of Industry." It conveys heavy, bulky loads of every description to any point in the plant covered by the overhead monorail track.

One man is in complete control of the load at all times. By merely operating the control levers he moves heavy beams, castings and other loads to any point touched by the system.

Eliminate wasteful methods of load-handling, and establish a low cost inter-department handling system in your plant.

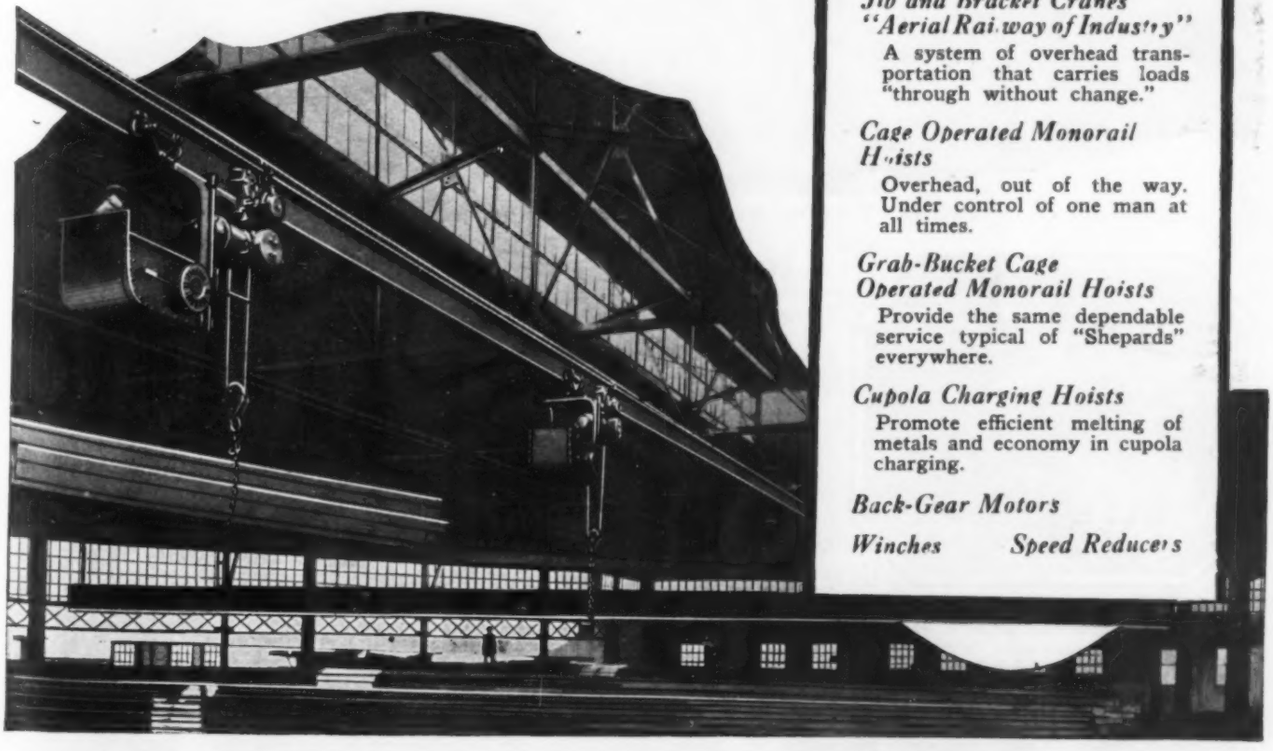
Write us now for a copy of the Shepard "Aerial Railway of Industry" bulletin. Also, let us send you information on any of the Shepard products listed at the right.

SHEPARD ELECTRIC CRANE & HOIST COMPANY

376 Schuyler Ave., Montour Falls, N. Y.

Branches in principal cities.

Member Electric Hoist Manufacturers' Assn.



For Every Lifting and Load-Moving Service

Shepard Electric Lift About
Sturdy ½ and 1 ton electric hoist. Quick, speedy, and safe.

Floor Operated Electric Hoists
In capacities to 10 tons.

Electric Traveling Cranes
For years and years of consistent crane service. Capacities to 30 tons.

Grab-Bucket Cranes
For handling coal, ashes, fertilizer, cement, etc.

Transfer Cranes
An efficient part of an inter-department handling system.

Single I-Beam Cranes
Provide lifting facilities at every point on a floor or bay.

Jib and Bracket Cranes
"Aerial Railway of Industry"
A system of overhead transportation that carries loads "through without change."

Cage Operated Monorail Hoists
Overhead, out of the way. Under control of one man at all times.

Grab-Bucket Cage Operated Monorail Hoists
Provide the same dependable service typical of "Shepards" everywhere.

Cupola Charging Hoists
Promote efficient melting of metals and economy in cupola charging.

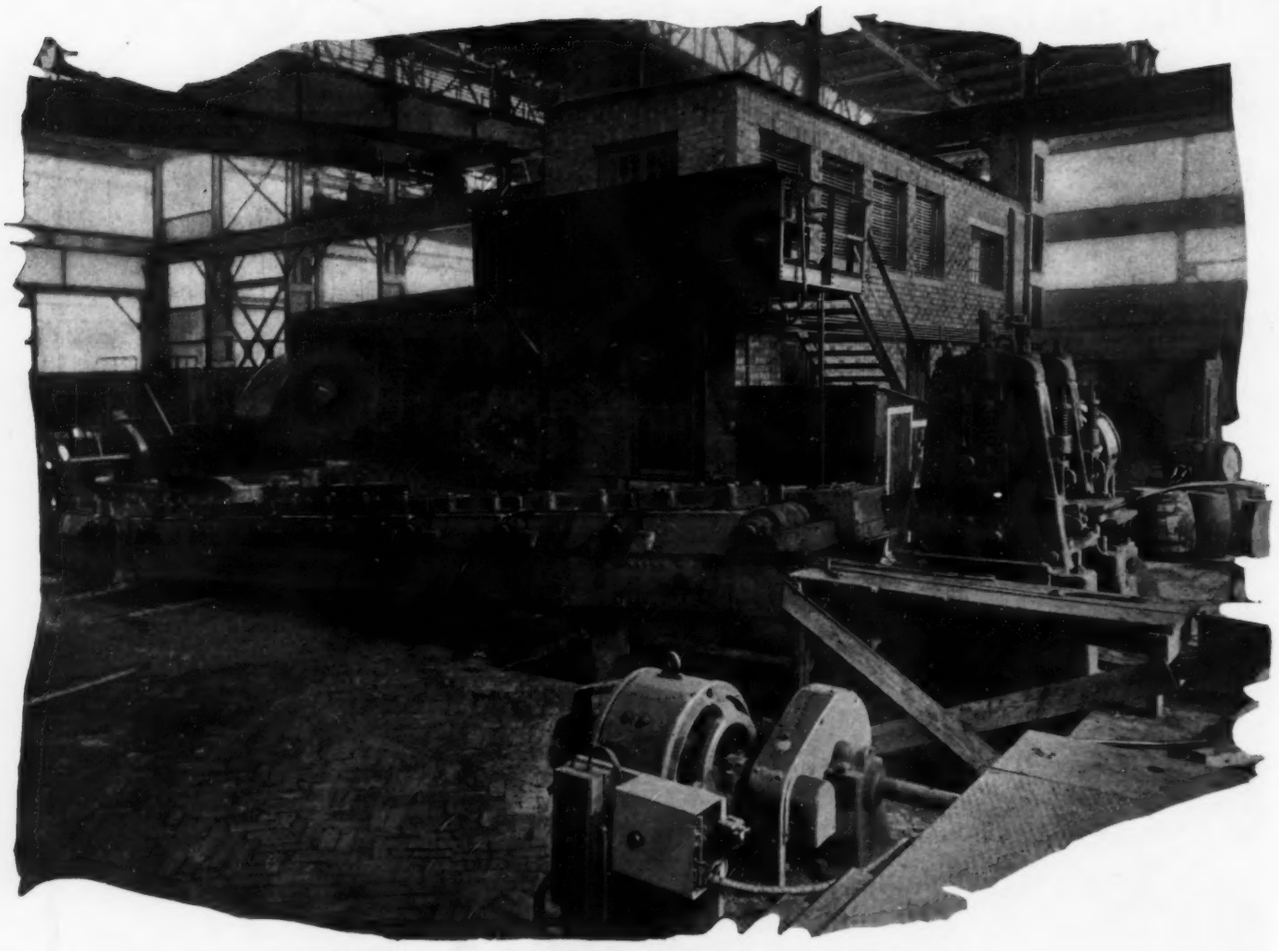
Back-Gear Motors

Winches ***Speed Reducers***

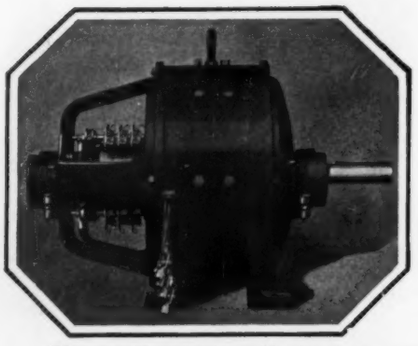
REG. U.S. PAT. OFF.

SHEPARD

ELECTRIC CRANES & HOISTS



Type T Heavy Duty Reliance Motors driving pinch rolls and conveyor



We accept as our guide in motor design the practical experience of operating engineers who know from actual results on the job how motors must be built to stand up to the tough jobs.

"Heavy Duty"—an earned title

Type T Reliance Motors were designed as general purpose motors to do more than meet ordinary needs. They were termed "heavy duty" motors. Eight years of satisfactory service on jobs like those illustrated above have proved that these motors deserve their title "heavy duty."

Type T motors are carefully built with plenty of good material in vital spots. They will withstand the strain of continuous hard service. They are well insulated to meet the unfavorable conditions surrounding many applications in steel and tube mills. Complete evidence of this is given in our Bulletin 2014, which we shall be glad to send.

Reliance Electric & Engineering Company

1080 Ivanhoe Road, Cleveland, O.

Branches: Boston, New York, Philadelphia, Pittsburgh, Cincinnati, Detroit, Chicago Birmingham, Ala.

Type T Heavy Duty RELIANCE MOTORS Direct Current

Not a single complaint in four years—

A remarkable record and a candid statement of a Contracting Engineer. Read it!

Slip on Link

Insert in Case

Put on Cap

That's all!

J. M. CLAYTON COMPANY
CONTRACTING ELECTRICAL ENGINEERS
8 COMB STREET
P. O. Box 1383

ATLANTA, GA.
Jan. 16th, 1924.

Bussmann Manufacturing Co.,
St. Louis, Mo.

Gentlemen:-

We are renewing our fuse contract with you for the year 1924 and wish to take advantage of this occasion to advise you that we have in connection with our work in the various industrial plants in this territory, installed a considerable number of your fuses ranging in size from 5 to 600 amperes.

We have found your renewable fuses very satisfactory and believe that our clients have been more than pleased with the Bussmann fuse. We have not had a single complaint on these fuses and have been using them for the past four years.

Yours very truly,

J. M. CLAYTON COMPANY,
By Jm Clayton
President

JMC.J

What BUSS Fuses have done for others they will do for you

Examine a sample → I. & S. E. 7-24

BUSS FUSES

APPROVED IN ALL TYPES AND SIZES

TRADE BussFuses ELECTRICITY'S SAFETY VALVE MARK REG U.S. PAT. OFF.

"ELECTRICITY'S SAFETY VALVE" MEANS ON

BUSSMANN MANUFACTURING CO. St. Louis, Mo.
3819 North Twenty-Third Street,
Without obligation, send me for examination sample 100 ampere, 250 volt Knife Blade Type BUSS Renewable Fuse.

Name _____ Position _____
Company _____
Street _____
City _____ State _____

The new maximum

OHIO LIFTING MAGNET

at work in the large, modernly equipped, scrap yard of The David Joseph Co., at Youngstown, Ohio.

Note the nearly straight side, allowing more room inside for the coil and eliminating damage to railroad cars.

Top is rounded, bolts well protected and terminals are absolutely guarded from mechanical or electrical damage.

Lifting capacity has been increased in this new Ohio Magnet design; insulation has been improved and permanency of waterproofing insured.

The Ohio Electric & Controller Co.

Cleveland, Ohio

OR ASK OUR REPRESENTATIVE

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Hunter L. Betts, 405 So. Franklin St., Syracuse, N. Y.
K. I. Clisby, Woolworth Bldg., New York City, N. Y.
S. G. Elbe, 211 Tramway Bldg., Denver, Colo.
Electric Sales Co., 1612 Maple Ave., Los Angeles, Calif.
A. J. Haywood, 88 Broad St., Boston, Mass.
Holden Company, Ltd., 350 St. James St., Montreal, Canada; 342 Adelaide St., West Toronto, Canada; 150 Princess St., Winnipeg, Canada; 81 Pender St., West Vancouver, B. C.
Howard & Geeseka Co., 826 Plymouth Bldg., Minneapolis, Minn.
H. A. Killam, 312 McKay Bldg., Portland, Ore.
A. S. Lindstrom, 111 New Montgomery St., San Francisco, Cal.
G. H. Maire, 95 Connecticut St., Seattle, Wash.
Charles J. Mundo, 380 Union Trust Bldg., Pittsburgh, Pa.
Linn O. Morrow, 811 Schaff Bldg., Philadelphia, Pa.
Nixon-Hasselle Co., Chattanooga, Tenn.
J. R. Petree, 1435 Marine Trust Bldg., Buffalo, N. Y.
Southern Industrial Engineering Co., Birmingham, Ala.
C. H. Stem, Audubon Bldg., New Orleans, La.
D. O. Stewart, 619 Bank of Commerce Bldg., St. Louis, Mo.
W. H. Williams, 53 West Jackson Blvd., Chicago, Ill.
C. E. Wise, General Motors Bldg., Detroit, Mich.

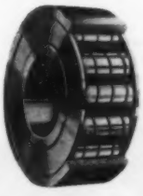
Hyatt bearings in this mounting replace existing plain bearings in cement mill motors with only the simplest machining operations on the shaft and frame. Send us data on motors, for which you would like to secure the advantages of Hyatt bearings, and we will let you know what machine work is required.

For the Motor that Runs in Grit-Laden Atmosphere

CEMENT, limestone, coke, ore, sinter—all are penetrating and abrasive dusts that quickly cut plain bearings. Bearing wear drops armatures out of center causing damaged windings, oil leakage and rotted insulation. Maintenance costs are high.

Hyatt Bearings in this class of service have practically eliminated these troubles. Plain bearings that averaged 90 days life have been replaced by Hyatt Bearings that are still going after four years, and motor failures from electrical and mechanical causes have practically disappeared.

Obviously such changeovers are a good investment.



HYATT ROLLER BEARING COMPANY
NEWARK, NEW JERSEY

HYATT ROLLER BEARINGS FOR ELECTRIC MOTORS

SAFETY
V·V
SWITCHES
QUICK POSITIVE MAKE
QUICK WIDE BREAK
30-60
100-200
Ampere
250-500
600
Volts
V.V.
Sturdy
Construction
V.V.
Mechanical
Perfection
Cast Iron—Type WBG—Weatherproof
WITH THE USUAL V. V. SAFETY FEATURES
V. V. FITTINGS COMPANY
New York
50 Church St.
PHILADELPHIA, U. S. A.
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532 So. Canal St.
Pittsburgh Representative
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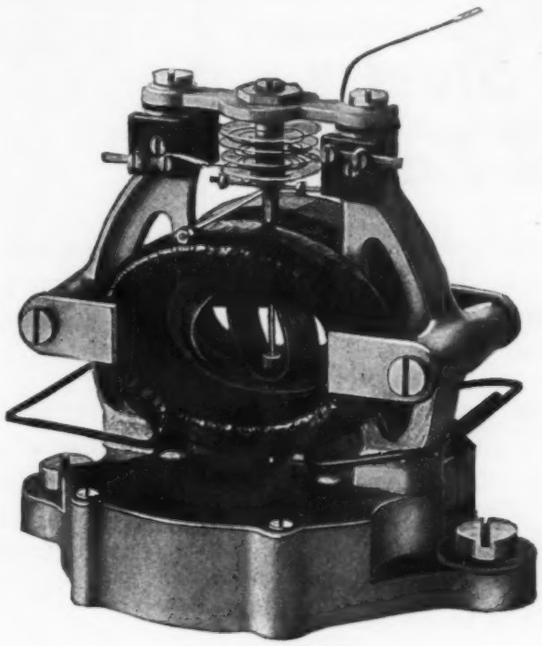
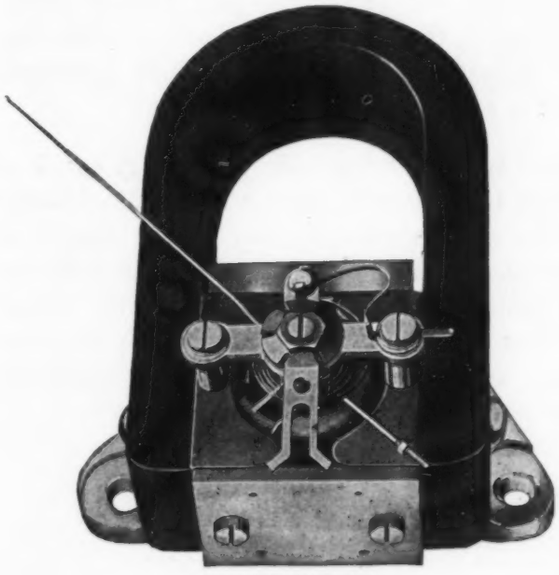
933 Liberty Ave.
Cleveland Representative
S. R. Shepard
1240 Ontario St.
CONDUIT
V·V
FITTINGS



ROLLER-SMITH
Power Factor Meter Mechanism



ROLLER-SMITH
Standard Direct Current Mechanism

Some NEW and INTERESTING Roller-Smith Bulletins

Check the ones you want, fill in the card at the bottom, tear out this ad and mail it to us.

No. AK-10. 3½" Instruments for Radio Sets
No. AK-40. Radio PV Voltmeter
No. AK-110. Small Portable D. C. Instruments
No. AK-150. Small Portable A. C. Instruments
No. AK-160. Large Portable A. C. Instruments
No. AK-200. Bond Testers
No. AK-210. Large Portable D. C. Instruments
No. AK-240. Torsion Balances
No. AK-420. 3½" and 4" Switchboard A. C. Instruments
No. AK-560. Enclosed Circuit Breakers

Roller-Smith Company:
Please send me the Bulletins checked above.

Name .....

Company .....

Address .....

City..... *State*.....

ROLLER-SMITH COMPANY
Electrical Instruments, Meters and Circuit Breakers

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2131 Woolworth Bldg., NEW YORK

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CLEVELAND, 7016 Euclid Ave.
DALLAS, 2002 Live Oak St.
DENVER, U. S. Nat'l Bank Bldg.
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NEW ORLEANS, Whitney Central Bldg.
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PITTSBURGH, Keenan Bldg.
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ST. LOUIS, Railway Exchange Bldg.
ST. PAUL, Pioneer Bldg.
SAN FRANCISCO, 589 Howard St.
SCRANTON, 939 Capouse Ave.
SEATTLE, Hinckley Bldg.
TORONTO, 183 George St.

Fig. 1.

Fig. 2.

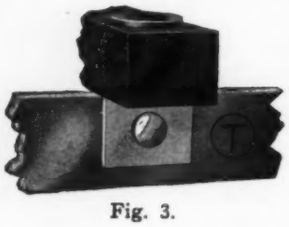


Fig. 3.

Fig. 4.

Iron and Steel Electrical Engineers:

You Iron and Steel Engineers represent probably the first body of men who individually and collectively appreciated that to obtain safety in switches something far more was necessary than just a safety box.

No body of men know better than you the unfortunate position in which safety switches have been placed because of a long drawn propaganda by salesmen and press eulogizing the safety box which keeps the operator away from the live parts of the switch. Such propaganda paid no attention whatever to the first necessity of safety in switches—namely the type of switch in the box that is to do the work.

From the beginning until now, there are few manufacturers and fewer contractors and engineers who pay enough attention to the construction of the knife switch proper, thinking as they do that safety switches mean a safety box surrounding most any kind of a switch.

Even the Underwriters in classifying safety switches speak of Class A, Class B, Class C or even Class AA in terms of boxes only—disregarding the switch entirely—an A box may contain the cheapest switch imaginable. One safe switch for industrial use is the Trumbull Type A manufactured for nearly twenty-five years. The Trumbull type A switch is machine made—built-up, most rigidly constructed and **quick-make** and **quick-break.** It will stand up under use and abuse.

The Illustrations Show

Figure 1—Foot-block and the pin that fastens the blades to the foot-block after it has been sweated.

Figure 2—Shows contact jaw complete.

Figure 3—Shows method of fastening the blade to the fibre cross-bar, making a unit of the blade and crossbar.

Figure 4—Shows long and strong quick make quick break spring that at no time is worked more than 50 per cent of its capacity.

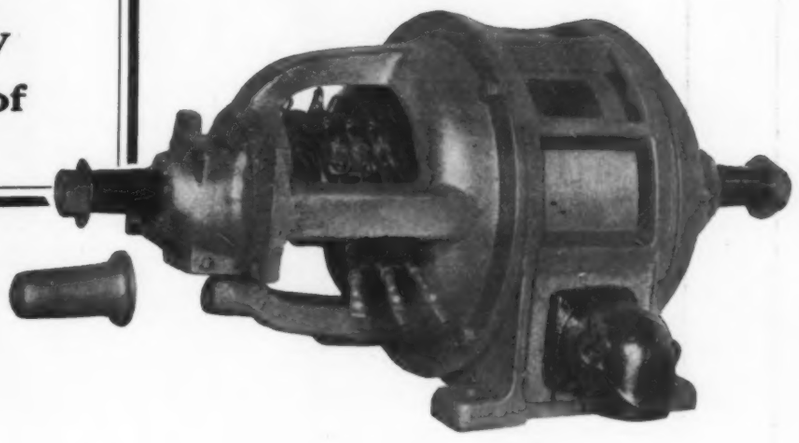
The Trumbull Electric Mfg. Company

114 Liberty St., New York City
595 Mission St., San Francisco, Cal.

Plainville, Conn.

2001 W. Pershing Rd., Chicago, Ill.
Boston Philadelphia Atlanta

—quality of motor
—accessability of service
—speed of delivery
—fairness of price



Which do you look for?

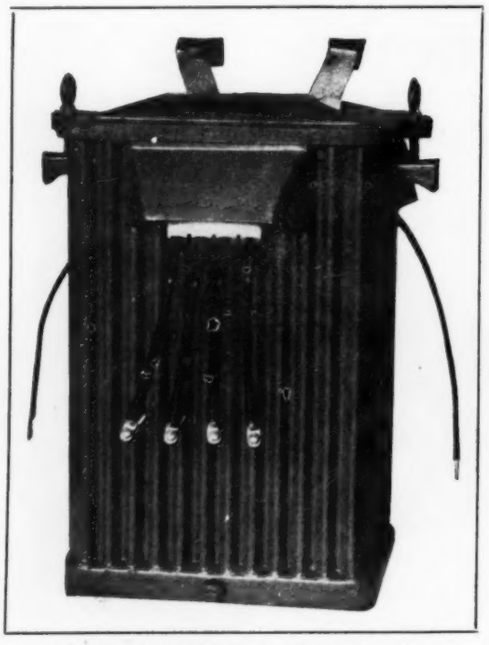
In the motors you specify, which of these features most directly governs your choice?

Standardize on Western Electric motors and control, and it is not a question of "Which?" but a certainty of all these requirements.

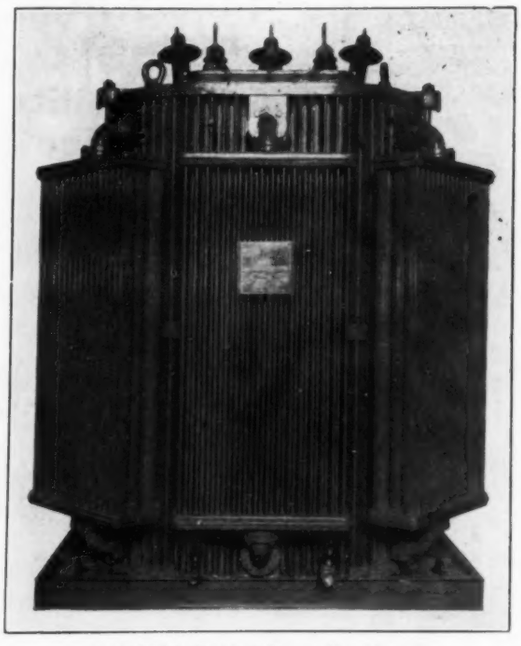
The how and why of this is a story we should like the privilege of telling you in person. Just say the word to our nearest Distributing House, or write to Western Electric Company, 100 East 42nd St., New York City.

Western Electric

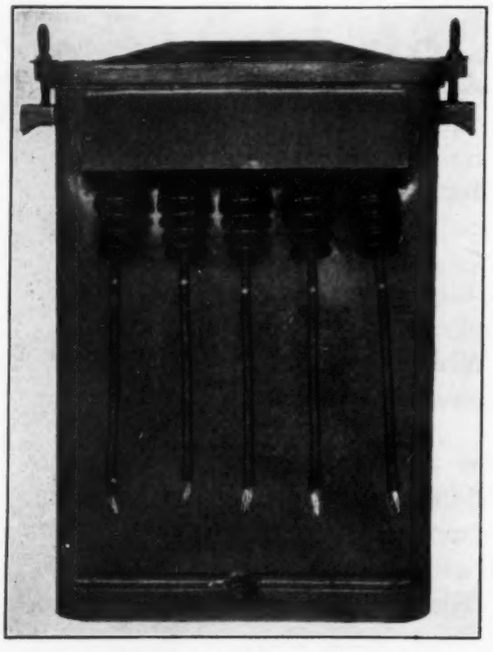
Chicago
Buffalo
Pittsburgh
Youngstown
Cleveland
New York



Packard "Sport Model" Distribution Transformer



1000 KV-A Packard Power Transformer



Packard Weather proof Metering Transformer Combines Potential and Current elements in one Tank Oil Filled

There is a *Packard* for your service

If you have not gone over the PACKARD line in the past few years you will be pleased with the improvements you find.

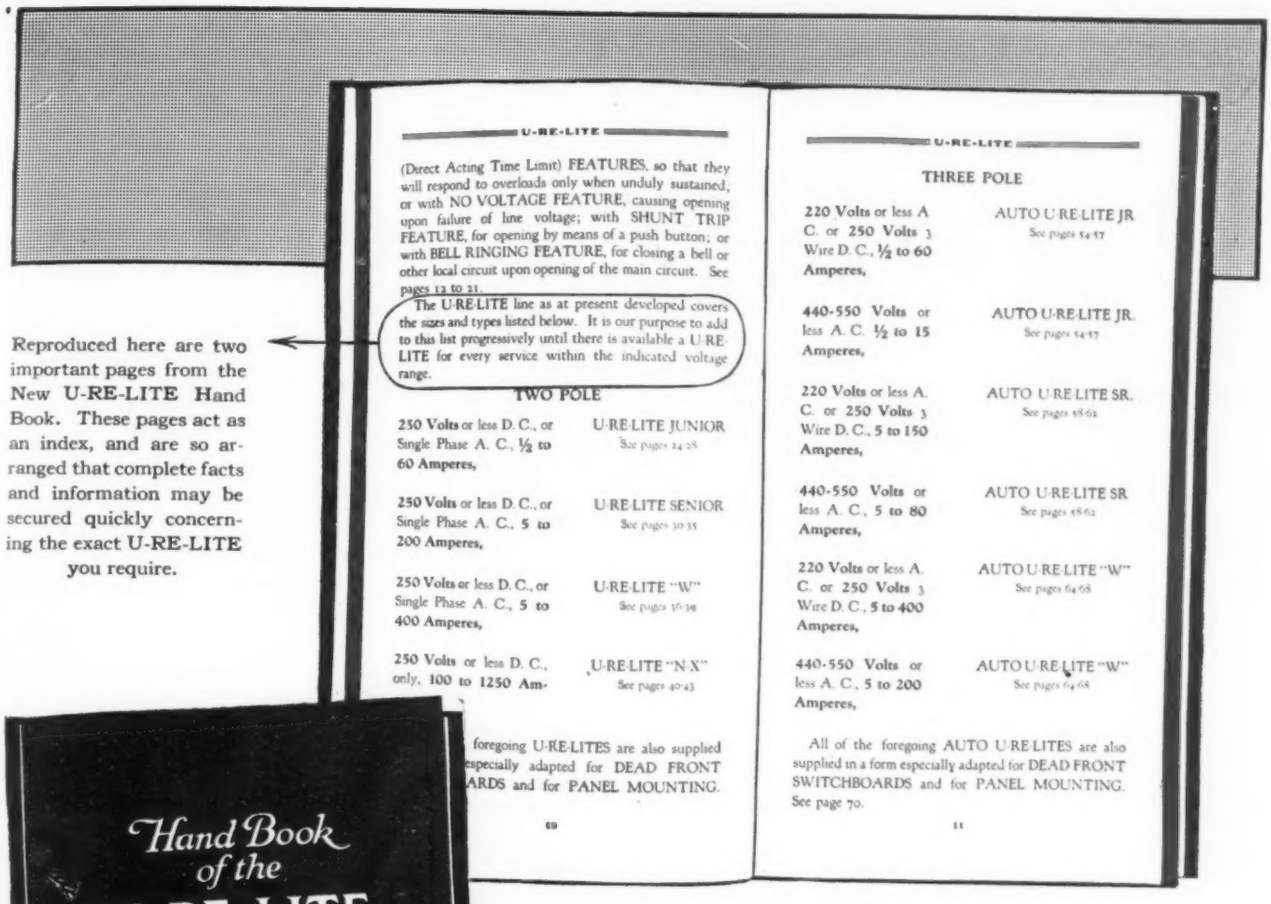
There is a continuous and, we are pleased to say, a successful effort being made to improve PACKARD transformers—both electrically and mechanically—while at the same time, where possible, without lowering the quality of the transformer, reduce the cost of their construction.

PACKARD transformers are today receiving a preference by some of the most particular engineering authorities in the country.

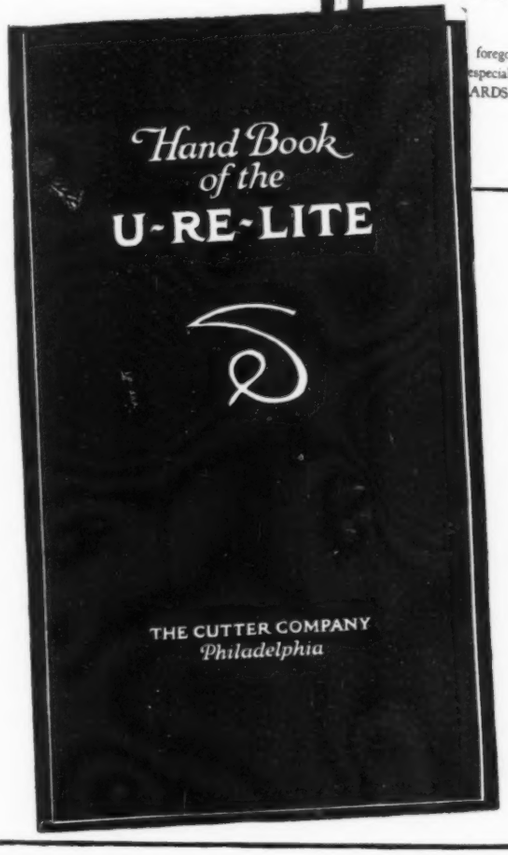
The Packard Electric Company

WARREN OHIO

Manufacturers of Transformers since 1890


U-RE-LITE
(Direct Acting Time Limit) FEATURES, so that they will respond to overloads only when unduly sustained; or with NO VOLTAGE FEATURE, causing opening upon failure of line voltage; with SHUNT TRIP FEATURE, for opening by means of a push button; or with BELL RINGING FEATURE, for closing a bell or other local circuit upon opening of the main circuit. See pages 12 to 21.
The U-RE-LITE line as at present developed covers the sizes and types listed below. It is our purpose to add to this list progressively until there is available a U-RE-LITE for every service within the indicated voltage range.
TWO POLE
250 Volts or less D. C., or Single Phase A. C., ½ to 60 Amperes, U-RE-LITE JUNIOR See pages 24-28
250 Volts or less D. C., or Single Phase A. C., 5 to 200 Amperes, U-RE-LITE SENIOR See pages 30-35
250 Volts or less D. C., or Single Phase A. C., 5 to 400 Amperes, U-RE-LITE "W" See pages 36-39
250 Volts or less D. C., only, 100 to 1250 Am- U-RE-LITE "N-X" See pages 40-43
foregoing U-RE-LITES are also supplied especially adapted for DEAD FRONT ARDS and for PANEL MOUNTING.
10
U-RE-LITE
THREE POLE
220 Volts or less A C. or 250 Volts 3 Wire D. C., ½ to 60 Amperes, AUTO U-RE-LITE JR See pages 14-17
440-550 Volts or less A. C. ½ to 15 Amperes, AUTO U-RE-LITE JR. See pages 14-17
220 Volts or less A. C. or 250 Volts 3 Wire D. C., 5 to 150 Amperes, AUTO U-RE-LITE SR. See pages 58-62
440-550 Volts or less A. C., 5 to 80 Amperes, AUTO U-RE-LITE SR See pages 58-62
220 Volts or less A. C. or 250 Volts 3 Wire D. C., 5 to 400 Amperes, AUTO U-RE-LITE "W" See pages 64-68
440-550 Volts or less A. C., 5 to 200 Amperes, AUTO U-RE-LITE "W" See pages 64-68
All of the foregoing AUTO U-RE-LITES are also supplied in a form especially adapted for DEAD FRONT SWITCHBOARDS and for PANEL MOUNTING. See page 70.
11

Reproduced here are two important pages from the New U-RE-LITE Hand Book. These pages act as an index, and are so arranged that complete facts and information may be secured quickly concerning the exact U-RE-LITE you require.



The U-RE-LITE is primarily an appliance for the protection from overloading electric motors and power or lighting circuits. It does this by automatically opening the circuit in the event of excessive current flow. It is, in a word, an electric safety valve. It does what fused switches are intended to do, but accomplishes this end without attendant expense. When the U-RE-LITE is opened by an overload, it does not require the insertion of renewal parts, but by a twist of the wrist may be instantly reset.

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Simplicity of Inlet Nozzle Cover

Simplicity of design shown in assembly of Motor and impeller

Simplicity of construction shown by removing Inlet Nozzle cover

A-c. Motor-driven Blower

Type FS-563

—specially suited for supplying air to oil furnaces

—operates over a wide range of load, with high efficiency

—lubricating system entirely enclosed

—sufficient oil supplied to bearings under pressure from pump built into blower

—supplies 4200 cu. ft. air per min. against 2 lbs. pressure

The Simplicity

of this Blower insures better service

In this new blower *fewer parts*, built right, give more satisfactory service, longer life and less maintenance—than can be obtained with blowers of complicated construction.

The bearings and rotating elements are readily accessible—the casing may be easily revolved and the discharge opening located to accommodate the simplest piping arrangement—the supports are in one plane.

Easy to install and maintain.

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